LOCAL STRUCTURE PLAN

PART 1 and 2

PROJECT TITLE: Treendale Structure Plan Policy Area 3B (amended)

DATE: 22nd DECEMBER 2020

Report Issue History

Report Issue	Job Number	Issued To	Issue Date
Original	190120	Allan Erceg	16/12/2020
Revised	190120		22/12/2020
Final	190120	WAPC	24/03/2023

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ENDORSEMENT

This structure plan is prepared under the provisions of the Shire of Harvey District Planning Scheme No 1.

IT IS CERTIFIED THAT AMENDMENT NO. 1 TO THE TREENDALE POLICY AREA 3B LOCAL STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON:

06 APRIL 2023

Signed for and on behalf of the Western Australian Planning Commission:

An officer of the Commission duly authorised by the Commission pursuant to section 16 of the *Planning and Development Act 2005* for that purpose.

TABLE OF AMENDMENTS

AMENDMENT NO.	SUMMARY OF AMENDMENT	AMENDMENT TYPE	DATE APPROVED WAPC
1	Incorporates the Bunbury Outer Ring Road alighnment. Increased lot yield from 75 lots to 124 rural residential lots	-	06 April 2023

EXECUTIVE SUMMARY

This Local Structure Plan (LSP) report has been prepared in accordance with the Western Australian Planning Commission (WAPC) Structure Plan Framework (August 2015) for the area defined as Treendale Policy Area 3B.

This LSP will facilitate the rural residential development of the land and has been prepared pursuant to Part 4 of the Deemed Provisions of the *Planning and Development (Local Planning Scheme) Regulations 2015*.

The Local Structure Plan comprises the following:

Part One – Implementation
Part Two – Explanatory Section; and
Appendices – Technical reports, plans, maps and supporting documents.

The summary provides key statistics and planning outcomes of the LSP as follows:

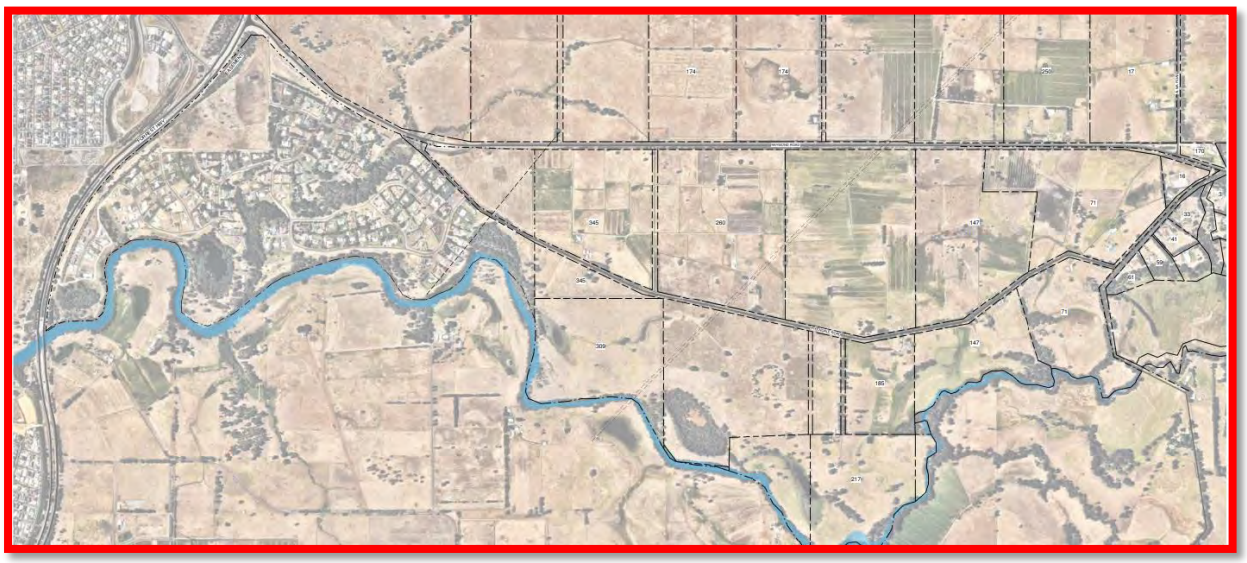
Table 1: LOCAL STRUCTURE PLAN SUMMARY TABLE

ITEM	DATA	STRUCTURE PLAN REF (SECTION NO)
TOTAL AREA COVERED BY STRUCTURE PLAN	429ha	1.2.2
AREA OF EACH LAND USE: **I: RURAL RESIDENTIAL (STAGE ONE ONLY)**	301HA	1.2 3.0
TOTAL ESTIMATED LOT YIELD	124 Lots	3.0
ESTIMATED NUMBER OF DWELLINGS	124	
ESTIMATED POPULATION	*323 people	

**Note: Population based on 2016 ABS data, 2.6 people per household and approximate yield of 124 lots.*

FIGURES

TECHNICAL STUDIES APPENDICIES



PART 1- IMPLEMENTATION

PART 1 IMPLEMENTATION

1.0 LOCAL STRUCTURE PLAN AREA

The Local Structure Plan (LSP) shall apply to the land contained within the inner edge of the line denoting the LSP boundary of the Structure Plan (SP) map.

2.0 OPERATION

In accordance with *Planning and Development (Local Planning Scheme) Regulations 2015*, the LSP shall come into effect when it is granted final approval and endorsed by the Western Australian Planning Commission (WAPC).

3.0 STAGING

The proposed staging of the SP area is fundamentally linked to the progression of the Bunbury Outer Ring Road (BORR). The progression and commitment of the construction of the BORR Northern End has been a catalyst for landowners to bring forward subdivision and development for land generally in proximity to the alignment of the BORR. Stage 2 landowners are not impacted as directly by the BORR however remain committed to future subdivision and development options. Stage 3 represents future logical development subject to the required detailed planning.

4.0 SUBDIVISION AND DEVELOPMENT REQUIREMENTS

4.1 Land Use Permissibility

Subdivision and development of land shall be in accordance with the zones and reserves assigned on the LSP Map. The land use permissibility within the LSP area shall be in accordance with the corresponding zone or reserve under the Scheme.

4.2 Information required at time of subdivision

The following information is to be provided prior to subdivision:

1) A Noise Exposure Forecast is to be submitted to identify the requirement for any noise mitigation from the Bunbury Outer Ring Road is required in accordance with State Planning Policy 5.4 Road and Rail Transport Noise and Freight Consideration.
2) A Bushfire Management Plan addressing State Planning Policy 3.7 – Planning In Bushfire Prone Areas.
3) A site specific site and soil evaluation in accordance with the Government Sewerage Policy.

4.3 Recommended Subdivision Conditions

The following shall be applied as conditions of subdivision:

1) Preparation, adoption and implementation of an approved Urban Water Management Plan to the specifications of the Shire of Harvey and in consultation with the Department of Water. The UWMP will be in accordance with 'Better Urban Water Management' and will address water sensitive urban design.
2) A geotechnical report is to be submitted to the satisfaction of the Shire of Harvey.

3) A mosquito-borne disease and nuisance risk assessment and a mosquito management plan prepared by an appropriately qualified person are to be submitted and endorsed to the satisfaction of the Shire of Harvey.
4) A notification, pursuant to Section 165 of the Planning and Development Act 2005 is to be placed on the certificates of title of the proposed lot(s) advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan).

   The notification is to state as follows:

   "This lot is on close proximity to known mosquito breeding areas. The predominant mosquito species is known to carry viruses and other diseases." (Western Australian Planning Commission).
5) A Bushfire Management Plan is to be implemented to the satisfaction of the Shire of Harvey.
6) A notification, pursuant to Section 165 of the Planning and Development Act 2005, is to be placed on the certificate(s) of title of the proposed lot(s) with a Bushfire Attack Level (BAL) rating of 12.5 or above, advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan).

   The notification is to state as follows:

   'This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and is/may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on the land.' (Western Australian Planning Commission).
7) A Foreshore Management Plan and Wetland Management Plan are to be prepared and approved by the Department of Water and Environmental Regulation and Department of Biodiversity, Conservation and Attractions to ensure the protection and management of the sites environmental assets with satisfactory arrangements being made for the implementation of the approved plans.
8) A notification, pursuant to Section 165 of the Planning and Development Act 2005 is to be placed on the certificates of title of the proposed lot(s) advising that a reticulated sewer service is not available to the land and that alternative effluent disposal units may be required to address constrained on-site conditions.
9) Intersections with Raymond Road shall be designed and constructed to the specifications of Main Roads WA.

RAYMOND ROAD

STAGE 3
SPECIAL
RESIDENTIAL

TREENDALE ROAD

SUBJECT TO FUTURE ROAD
CLOSURE OF PORTION OF
TREENDALE ROAD

STAGE 1

STAGE 2

TREENDALE ROAD

OPEN SPACE

LEGEND

LOCAL SCHEME RESERVES

PUBLIC PURPOSE - NOISE BUND

ZONES

RURAL RESIDENTIAL

RESERVED ROADS

PRIMARY REGIONAL ROADS

OTHER

ACCESS ROAD

STRUCTURE PLAN BOUNDARY

EXISTING CADASTRE

DRAINAGE BASIN

TREENDALE POLICY AREA 3B AMENDED LOCAL STRUCTURE PLAN

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RAYMOND ROAD

INDICATIVE FUTURE WIDENING OF RAYMOND ROAD CONSISTENT WITH THE GREATER BUNBURY REGION SCHEME

SPECIAL RESIDENTIAL

TREENDALE ROAD

SUBJECT TO FUTURE ROAD CLOSURE OF PORTION OF TREENDALE ROAD

EMERGENCY ACCESS WAY

TREENDALE ROAD

OPEN SPACE

LEGEND

LOCAL SCHEME RESERVES

PUBLIC PURPOSE - NOISE BUND

ZONES

RURAL RESIDENTIAL

RESERVED ROADS

PRIMARY REGIONAL ROADS

OTHER

ACCESS ROAD

STRUCTURE PLAN BOUNDARY

CONCEPT PLAN BOUNDARY

EXISTING CADASTRE

DRAINAGE BASIN

TREENDALE POLICY AREA 3B
CONCEPT PLAN
STAGE ONE

1:4000
At A1

0 50m 100 150 200 250 300 350 400

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PART 2 – EXPLANATORY SECTION & TECHNICAL APPENDICIES

PART 2 EXPLANATORY SECTION

1.0 PLANNING BACKGROUND

1.1 Introduction and Purpose

1.1.1 Overview

In noting the status of the Treendale Structure Plan Policy Area 3B 1996 and the advice from the Department of Planning, Lands and Heritage that the 1996 structure plan has full legal effect there is still a need to amend the document to address the implications of the Bunbury Outer Ring Road (BORR) as well as comprehensively addressing environmental and engineering servicing considerations.

The amended Structure Plan will provide the framework for the coordinated provision and arrangement of the land uses, subdivision and development. It will also inform the provision of a transport network, regional open space, public utilities and development standards.

1.1.2 Background and Planning History

On the 14th February 1996, the Western Australian Planning Commission (WAPC) advised the Shire of Harvey that it had resolved to endorse the Treendale Structure Plan Policy Area 3B. The area extended from Raymond Road through to the Colie River and east to Forrest Highway (appendix 6).

The only significant modification to the Structure Plan required by the Commission was to modify the Western Residential Precinct (now Meadow Landing) to reflect the higher density of Special Residential. The decision of the WAPC in relation to the Western Residential Precinct was formalised through the gazettal of Amendment No 23 to Town Planning Scheme No 1 in July 1999.

The Shire of Harvey advertised their Local Planning Strategy from July to September in 2019. The advertised Strategy showed the land on the south side of Treendale Road as Rural Residential and Priority Agriculture for the area between Raymond Road and Treendale Road.

A submission on the Local Planning Strategy made the case that there was an existing endorsed Structure Plan for the area between Raymond Road and the Collie River. Therefore, the Priority Agriculture area north of Treendale Road had been approved for Rural Residential development.

The Shire of Harvey Council accepted the submission to expand the Rural Residential area and adopted an amended Local Planning Strategy in May 2019. The Shire of Harvey submitted the adopted Local Planning Strategy to the WAPC for final endorsement. The officer's report to the Commission (via the Statutory Procedures Committee) did not recognise the 1996 Treendale Structure Plan as an endorsed plan by the Commission. As a consequence, the entire Treendale Structure Plan area remained as rural and the issue of land suitability for Rural Residential development was referred for consideration in the Bunbury Geographe Sub Regional Strategy planning process.

The suitability of the Treendale Structure Plan area has already been established and this revised Structure Plan, which now incorporates the Bunbury Outer Ring Road alignment, should advance through the planning approval procedures with full recognition of the endorsed 1996 Treendale Structure Plan.

1.2 Land Description

1.2.1 Site Location

The landholdings are located within the locality of Roelands in the Shire of Harvey, approximately 150kms south of the Perth Metropolitan area. The study area is situated immediately adjacent to the Collie River, approximately 3kms to the east of the Treendale District Centre. Stage One is comprised of approximately 300ha of predominantly cleared land. The Collie River borders the study area to the south, while the northern border of the study area is defined by Raymond Road. Immediately west of the landholdings is the special residential subdivision of Meadow Landing. The location of the study area is shown in Figure 1.

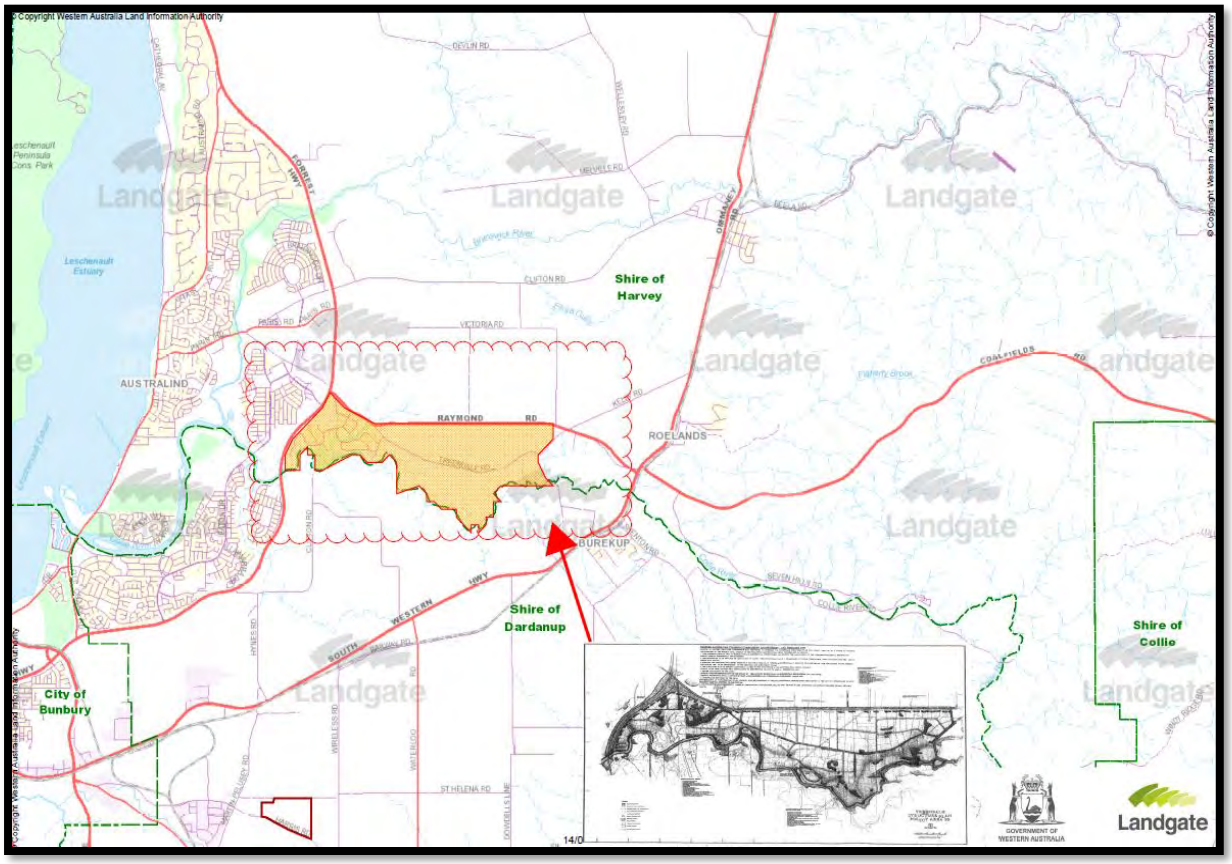

Figure 1 Location Plan

1.2.2 Area and Land Use

The land defined as the "Structure Plan Area' (Stage One) comprises approximately 300ha of farmland and river foreshore. The land is predominantly utilised for General Farming operations including cattle grazing and stock feed cropping (Hay).

The subject site includes within its boundary five Geomorphic Wetlands, one of which is the Collie River which is situated along the southern boundary of the subject site. Three of the mapped wetlands are "Multiple Use" one is classed as "Resource Enhancement" and one is classed as "Conservation". There is one Environmentally Sensitive Area (ESA) that extends within the subject site along the western boundary, this is associated with the Conservation wetland (UFI1734).

1.2.3 Surrounding Land Use

The locality has traditionally been an irrigated farming area supporting dairy herds and the area north of Raymond Road continues to be used for that purpose.

Immediately to the west and east of the Structure Plan area are the two major highways that service the South West region (Forrest Highway and South West Highway). Forrest Highway is soon to be affected by the alignment of the Bunbury Outer Ring Road which will pass through the western portion of the Structure Plan area.

The area between the highways and south of Raymond Road, has been subdivided immediately east and west of the Structure Plan. Land use in these areas is Special Residential to the west and Special Rural to the east.

Land use to the west of Forrest Highway is predominately urban with the Treendale town centre just 3 kilometres from the subject land. This ensures a full range of services and commercial facilities that are easily accessible (Figure 2 Local Context Plan).

The southern border of the subject land is the Collie River which has been severely modified with the construction of the Wellington Dam. Managed environmental flows have allowed important wetlands and riparian natural communities to survive. The river has significance to past and present aboriginal communities and will provide an important recreational resource to existing and future populations.

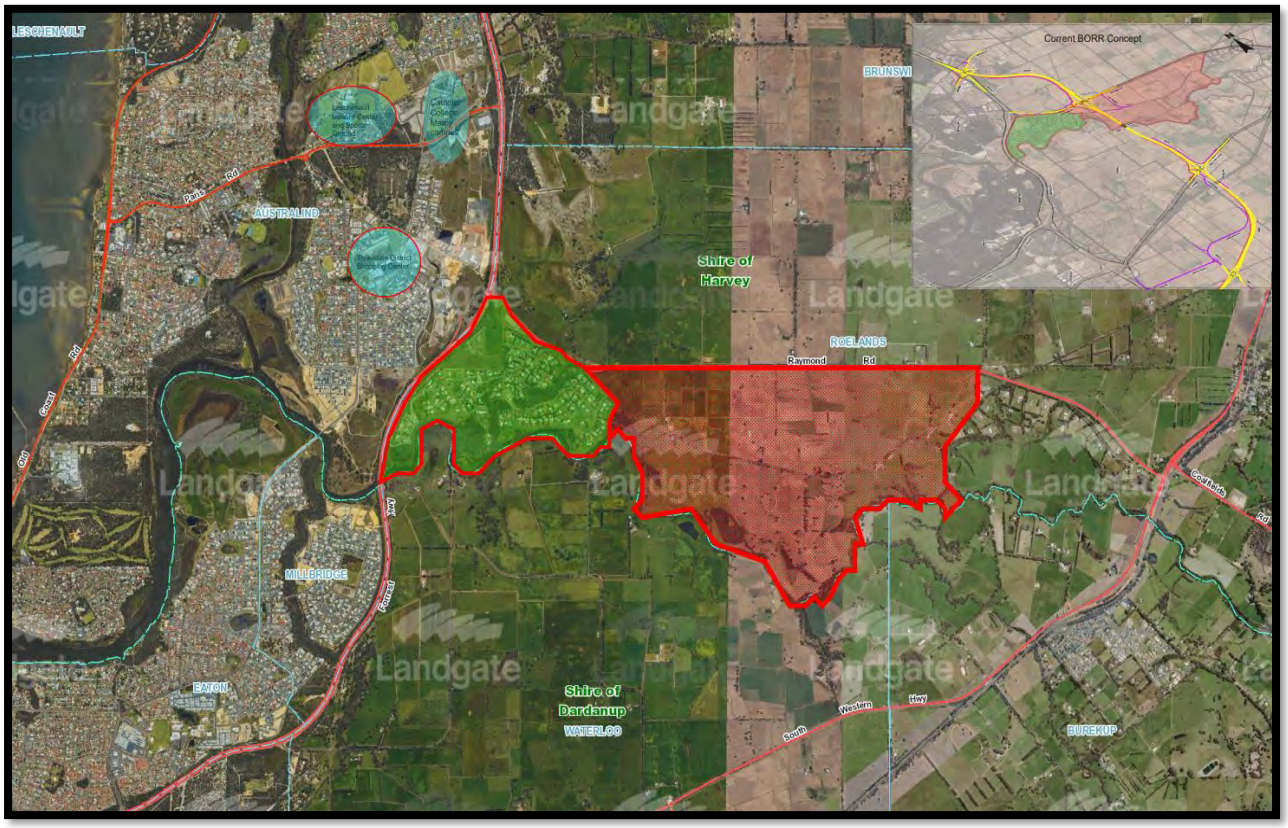

Figure 2: Local Context Plan

1.2.4 Legal Description and Ownership

Current ownership and property details as they relate to Stage One are recorded in the below table. Copies of the Certificate of Titles are contained in appendix 1.

Address	Plan No.	Certificate of Title	Landowner	Area (ha)
Pt Lot 100	P068088	2806/419	Robert Lindsay Taylor	80.3852(whole) Approx. 13 (portion in SP)
Lot 878 (No. 345) Treendale Road	P251812	1475/315	Commissioner of Main Roads	40.6484
Lot 1 (No. 260) Treendale Road	D005120	1003/348	Melissa Jane McIntyre	48.3793
Lot 2 (Multi-lot)	D005120	792/87	Crystal River Investments Pty Ltd	56.2820
Lot 3 (No.185) Treendale Road (Multi-lot)	D005500	792/87	Crystal River Investments Pty Ltd	16.1774
Lot 314 (No.217) Treendale Road	P246083	1405/876	Collie River Investments Pty Ltd	26.9585
Lot 246	P232718	1405/877	Collie River Investments Pty Ltd	13.0479
Lot 3315	P251811	1009/749	Collie River Investments Pty Ltd	54.0258
Lot 157 (No.309) Treendale Road	P418094	2983/347	Crystal River Investments Pty Ltd	25.3604
Lot 510	P418094	2983/348	Commissioner of Main Roads	7.1994
				Total Study Area 301 ha

Table 1: Land Ownership

1.3 Planning Framework & Background

1.3.1 Zoning and Reservations

Shire of Harvey Local Planning Scheme No.1

The land north of Treendale Road is currently zoned 'Intensive Farming' with land south of Treendale Road being zoned 'General Farming'.

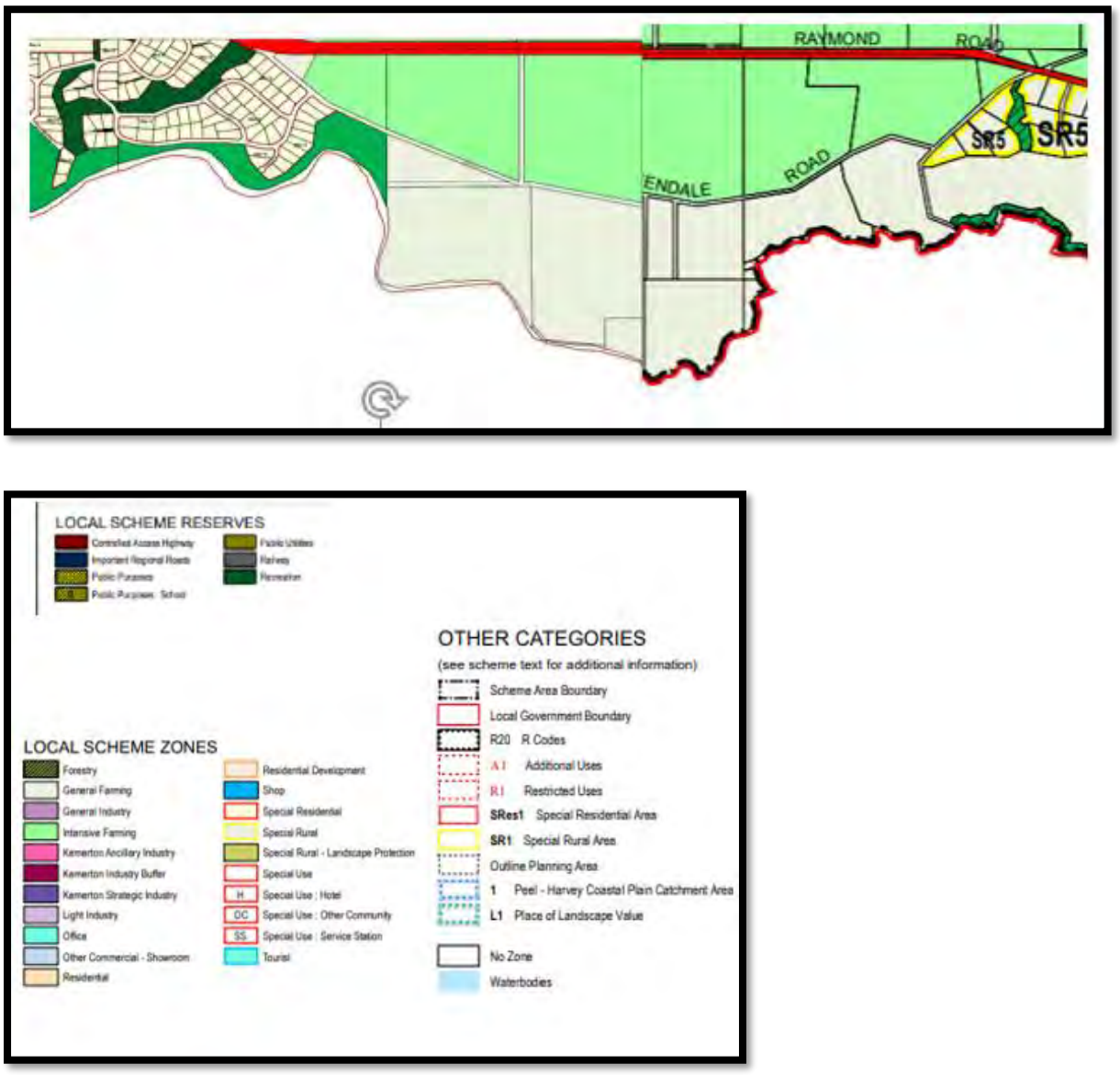

Figure 3: Extract from Shire of Harvey Local Planning Scheme No 1

Shire of Harvey Local Planning Strategy

Section 1.1.2 above refers to the detailed history and status of the Shire of Local Planning Strategy.

Following advertising of the draft Local Planning Strategy, the Shire of Harvey Council resolved to endorse a final document that included land north of Treendale Road as Rural Residential. The review of that document by the Department of Planning Lands and Heritage and subsequently the WAPC

resulted in a decision to not recognise the legal status of the 1996 Structure plan and as a consequence, the Local Planning Strategy was approved subject to the Structure Plan area remaining as rural and the issue of land suitability for Rural Residential is to be addressed through the Bunbury-Geographe Sub Regional Strategy planning process.

The Local Planning Strategy was formally endorsed by the Western Australian Planning Commission on 22nd April 2020. Figure 3 below depicts the Strategy plan as it relates to the Roelands locality. Land use for the subject land is depicted consistent with the Local Planning Scheme.

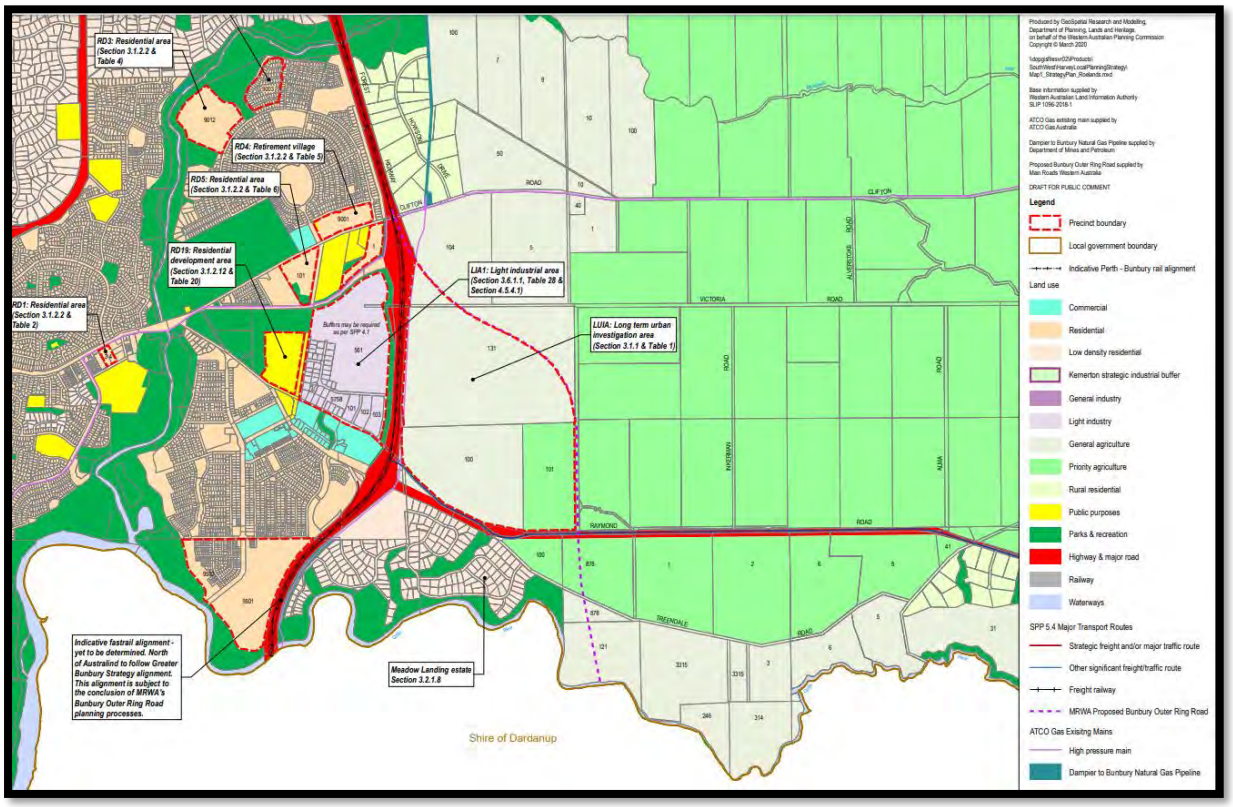

Figure 4: Extract from Shire of Harvey Local Planning Strategy

1.3.2 Regional and Sub-Regional Structure Plan

The Greater Bunbury Sub regional Structure Plan (2013) shows the subject land as Rural and this zoning is the subject of review through the current planning process associated with the Bunbury Geographe Sub regional Strategy.

Although Rural Residential has not been accepted by the W.A. Planning Commission (as recommended by the Sire of Harvey), an amended Structure Plan for the subject land is proceeding on the basis that the area has already received WA Planning Commission approval for Rural Residential development. It therefore unnecessary to undertake a further land suitability assessment to justify the Rural Residential zoning.

The draft Bunbury Geographe Sub regional Strategy is currently being advertised and the submission period closed on the 12th February 2021.

Greater Bunbury Region Scheme (GBRS)

The GBRS provides a high level strategic direction for the promotion of sustainable development in the region through regulation of subservient schemes, strategies and policies. The GBRS provides regional scale land allocation and mapping in order to guide the zoning of land, provision of infrastructure, protection of environmental assets, areas of regional open space, location of industrial areas, extraction of resources and protection of productive agricultural land.

The structure plan area is zoned 'Rural' under the GBRS. The purpose of the Rural zone is "to provide for agriculture, assist in the conservation and wise use of natural resources including water, flora, fauna and minerals, provide a distinctive rural landscape setting for the urban areas and accommodate carefully planned rural living developments".

The proposed 'Rural Residential' development is in accordance with the GBRS 'Rural' zoning and has been appropriately identified and planned for in this location, prior to the gazettal of the GBRS in October 2007. As a consequence, the proposed amendment to the Structure Plan will not necessitate an amendment to the GBRS zoning.

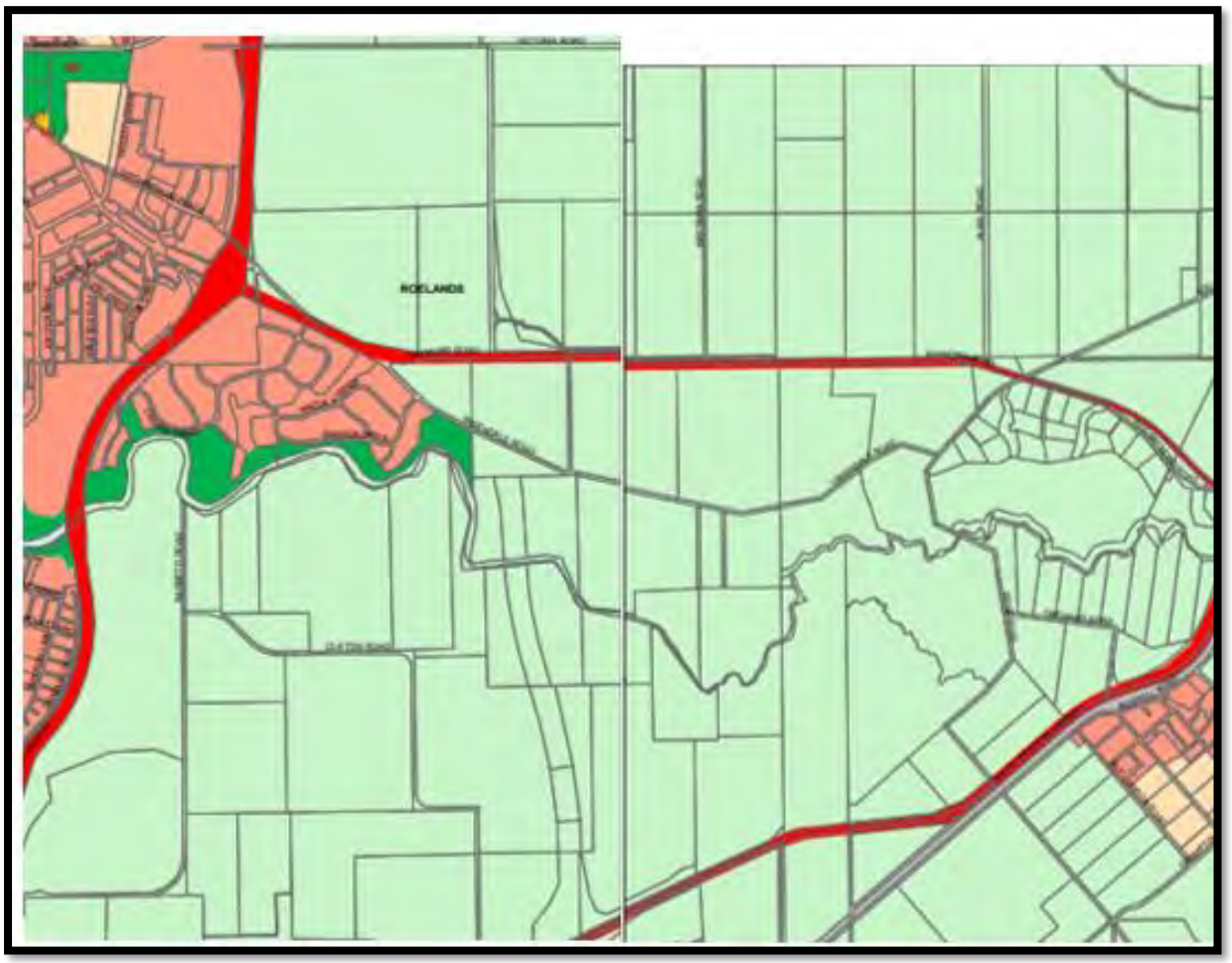

Figure 5: Extract from GBRS

1.3.3 Planning Policies

State Planning Policy No 3: Urban Growth Centres and Settlement

The State Planning Policy No 3: Urban Growth Centres and Settlement sets out the principals and considerations which apply to planning for urban growth settlement in Western Australia.

The main objectives of the policy include the promotion of;

- *a sustainable and well planned pattern of settlement across the State, with sufficient and suitable land to provide for a wide variety of housing, employment, recreation facilities and open space,*
- *existing communities with established local and regional economies, growth and development of urban areas in response to the social and economic needs of the community and*
- *development of a sustainable and liveable neighbourhood form which reduces energy, water and travel demand whilst ensuring safe and convenient access to employment and services by all modes.*

The Amended Structure Plan proposed is a logical infill of the existing Special Residential to the west and Special Rural to the east. This area is well serviced by road, power and water and is in close proximity to the major sub regional centre of Treendale where extensive social infrastructure is available.

The subject land is also close to major employment centres such as Kemerton, the retail and light industrial areas of Treendale, Australind and Eaton and the major industries in and around Collie.

The proposed Structure Plan is considered consistent with the intent of SPP 3 (WAPC 2003).

State Planning Policy No 3.7: Planning in Bushfire Prone Areas

The State Planning Policy 3.7 directs how land use should address bushfire risk management in Western Australia and applies to all land mapped by the Fire and Emergency Services (FES) Commissioner as being a Bush Fire Prone Area.

SPP 3.7 is supported by *Guidelines for Planning in Bushfire Prone Areas* which provides advice on how bushfire risk is to be addressed when planning, designing or assessing planning proposals within a designated bushfire prone area. The guidelines outline four performance based criteria for assessment:

Element 1: Location;
Element 2: Siting and Design of Development
Element 3: Vehicle Access; and
Element 4: Water

Table 5 of appendix 3 outlines the assessment under each of the above elements. The proposed Structure Plan is compliant with the acceptable solutions.

State Planning Policy No 5.4: Road and Rail Noise

This policy aims to promote a system in which sustainable land use and transport are mutually compatible. One of the main objectives of the policy is to protect people from unreasonable levels of transport noise.

The proposed development is in proximity to a future major highway and noise mitigation measures will need to be addressed. As per 4.1.2 of the policy, where any part of the lot is within the specified trigger distance, an assessment against the policy, specifically a Noise Exposure Forecast, is required prior to subdivision to determine the likely level of transport noise and management/mitigation required.

State Planning Policy No2: Environment and Natural Resources Policy

The objectives of the Policy are:

- To integrate environment and natural resource management with broader land use planning and decision-making,
- To protect, conserve and enhance the natural environment,
- To promote and assist in the wise and sustainable use and management of natural resources.

Relevant General Measures (5.1)

i) Avoid development that may result in unacceptable environmental damage.

ii) Actively seek opportunities for improved environmental outcomes including support for development that provides for environmental restoration and enhancement.

iv) Protect significant natural, indigenous and cultural features, including sites and features significant as habitats and for their floral, cultural, built, archaeological. ethnographic, geological, geomorphological, visual and wilderness values.

vii) Take account of the potential for on-site and off-site impacts of land use on the environment, natural resources and natural systems.

x) Support conservation, protection and management of native remnant vegetation where possible to enhance soil and land quality, water quality, biodiversity, fauna habitat, landscape amenity values and ecosystem function.

Relevant Water Resources statements (5.2)

Planning strategies, schemes and decision making should:

i) Consider mechanisms to protect, manage, conserve and enhance:
   b. waterways.

iii) Encourage urban water management through water sensitive designs approaches that better manage storm water quality and quantity, that reduces the impact of storm water flows to streams, wetlands and coastal waters and that control or remove pollutants and nutrients so as to improve water quality, retain habitats, conserve water and provide for recreational opportunities and conservation functions through multiple use drainage systems.

iv) Ensure provision of adequate setbacks between development and the foreshores of wetlands, waterways, estuaries and the coast in order to maintain or improve the ecological and physical function of water bodies. Such setbacks will aim to maintain the natural drainage function, protect wildlife habitats and landscape values, lessen erosion of banks and verges and facilitate filtration of sediments and waste associated with surface run-off from adjacent land uses, which may include retention or replacement of riparian vegetation.

v) Consider flood risk by identifying floodway's and land affected by 1 in 100 year flood events and avoid intensifying the potential for flooding as a result of inappropriately located land uses and development.

The application of this policy is primarily for the Collie River and its environs. As previously stated, the areas in the Structure Plan outside of the Collie River are severely degraded and therefore there is limited response required for the protection and management of natural values.

The subject land is located within the Leshenault Inlet Management Area which is designated as a Waterways Conservation Act Management Area. The Wetlands Management Plan (see appendix 2) sets out a comprehensive set of management actions which cover weeds, storm water and ground water, rehabilitation of degraded areas, flora and fauna, fire and revegetation of wetlands.

It is considered that the actions proposed in the Management Plan are consistent with the objectives and strategies of SPP 2 Environment and Natural Resources.

Government Sewerage Policy

5.2 On-site sewerage disposal

Where the provisions of 5.1.1 do not apply, onsite sewage disposal may be considered where the responsible authority is satisfied that:

- Each lot is capable of accommodating on-site sewage disposal without endangering public health or the environment; and
- The minimum site requirements for on-site sewage disposal outlined in this section and Schedule 2 can be met.

The lots proposed in the Structure Plan area are compliant with Schedule 2 of the Policy.

1.4 Pre-Lodgment Consultation

The proposed Structure Plan amendment has been discussed with representatives of the Shire of Harvey during a series of pre-lodgement meetings in April, October and December 2020. Discussions were also undertaken with officers of the WAPC in July 2020.

2.0 SITE CONDITIONS AND CONSTRAINTS

Within the Structure Plan area, the larger northern portion consists of cleared pasture composed of flat to very gently undulating plain with acidic mottled yellow duplex soils, comprising moderately deep/shallow pale sand to sandy loam over clay, being imperfectly drained.

The southern portion of the Structure Plan area is the Collie River floodplain which is characterised by gently undulating to flat terraces adjacent to the Collie River, but is well below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding.

In general, the vegetation condition of the project area is very degraded. The majority of the area has been parkland cleared and therefore retained little to no structure and native species. Areas of better vegetation occur along the foreshore areas of the river.

To assist in the preparation of this Local Structure Plan report, a number of background studies were undertaken for Stage one including:

- Wetland Management Plan;
- Engineering Servicing Report; and
- Bushfire Management Plan.

Copies of these reports are included in the schedule of appendices and are summarised below.

2.1 Biodiversity and Natural Assets

2.1.1 Flora and Vegetation Assessment

There are varying degrees of degradation throughout the project area caused by weed invasion, cattle access and historical clearing. Vegetation structure has been severely altered and as such the majority of the Structure Plan area is very degraded.

The completely degraded areas are associated with isolated *Eucalyptus rudis* trees over *Juncus subsecundus* grassland vegetation type as there is no vegetation structure retained. The dominant species is a mixture of Juncus and Cenchrus and there are obvious signs of multiple disturbances, with areas heavily accessed by cattle for grazing and drinking standing water. No areas of vegetation or wetlands themselves have been classified as being in good condition.

Of the 69 potential conservation significant species only one, *Eucalyptus rudis,* was identified and there were no priority or threatened ecological communities identified following survey. A total of 25 introduced species were recorded following survey which represented 71% of the total flora identified. The large representation of weeds indicates that the vegetation is in a degraded state with weeds starting to dominate.

2.1.2 Fauna

Fauna habitat values associated with the northern portion of the Structure Plan area have been severely reduced by historic clearing of native vegetation and cattle grazing. The few remaining large trees in this area are within a degraded habitat. Fair to good quality fauna habitat is evident where vegetation is present in pockets along the Collie River environs.

Twenty-six fauna species have been identified as part of a fauna survey comprising 22 birds, 3 mammals and 1 frog. Although not observed, black cockatoos (3 species) may have passed through this area based on the observation of some freshly chewed nuts.

2.2 Landform and Soils

2.2.1 Topography

The larger northern portion of the Structure plan area varies in height from 18m AHD in proximity to Treendale Road to 5m AHD at the point where it meets the Collie River floodplain. This results in slopes ranging from 0% to 17% with a generally southerly aspect. The floodplain of the Collie River varies in width from 20m to 450m and varies in elevation from 0m AHD to 5m AHD.

2.2.2 Acid Sulphate Soils

These soils and sediments are naturally occurring and contain sulphide minerals, predominately pyrite. When undisturbed below the water table these soils are benign and not acidic. However, if the soils are drained, excavated or exposed by lowering the water table, the sulphides will react with oxygen to form sulphuric acid.

Acid Sulphide Risk Mapping indicates that the Structure Plan area is within areas of both high to moderate risk and low to moderate risk. The low to moderate risk is the majority of the Structure Plan area whilst the high to moderate risk is situated within the Collie River wetland area.

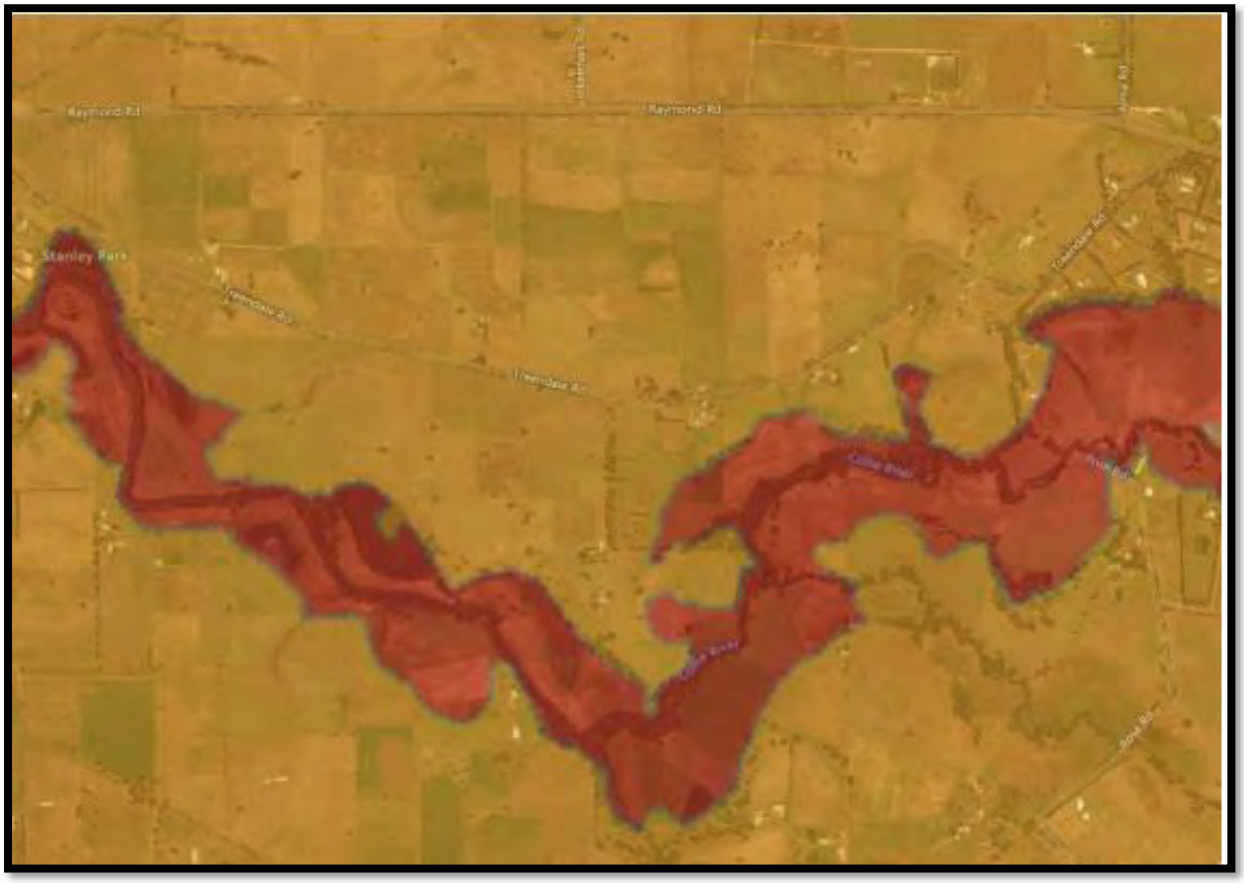

Figure 6: Acid Sulphate Soil Mapping

2.2.3 Geology and Soils

The Structure Plan area lies within the Pinjarra system. This system is described as poorly drained coastal plain with variable alluvial and aolian soils.

Soil testing results found that the area consists of duplex soils of varying depths (0.2m to 0.7m) of pale quartz sand overlaying dense highly plastic clays in the northern portion of the Structure Plan area. Within the South east, soils were found to be red earths (to 1.3m) overlaying hard packed yellow/orange and white/grey clay. Soil types in the southern floodplain area are described as red/brown loamy earth (1.2m to 2.7m) overlaying mottled grey/brown, orange/yellow or red/orange clays. The mottled clays from approximately 0.7m to 2.7m in this area indicate a perched winter water table or very low vertical hydraulic conductivity with the underlying superficial aquifer.

2.2.4 Soil Classification

As part of the land capability study undertaken By Cardno BSD (2008) for Lots 121, 246, 314 and 3315 Treendale Road Roelands, test pitting was undertaken to define soil composition. Fourteen test pits were excavated by backhoe to a maximum depth of 3.5m.

It was noted soils underlying the study area consisted of sandy clays with a thin surface horizon of quarts sand of vary depth. Surface soils were described as be expected to provide reasonable permeability, while subsoils can be expected to generally have low permeability.

Onsite investigations indicated that:

- Soils on the northern portion of the site are duplex quartz sand (0.2- 0.7m) over dense highly plastic clays. Clays were mottled at depths of 0.2-0.7m, suggesting a seasonal perched water table at this depth.
- Soils types underlying the southern floodplain portion of the site were noted to be red/brown loamy earth of between 1.2m and 2.7m depth overlying mottled grey / brown orange / yellow or red/ orange clays. These soils are noted as being consistent with those that could be expected to be found within alluvial floodplain areas.
- Soils analysis indicated that the surface soils underlying the northern portion of the study area had low to moderate nutrient retention capacity.

2.3 Ground Water and Surface Water

The Structure Plan area is not located in a Public Drinking Water Source Area, however is located in the proclaimed Bunbury Groundwater Area and the Australind (Bunbury) sub area.

Soil sampling undertaken by Cardno excavated pits to 2m – 4m with no water table encountered. There are numerous private groundwater bores in the area, however there is no recorded data on these. There are no DWER WIN bores within the subject area, however WIN bores are in proximity and have recorded groundwater at depths of between 1.2m and 11.1m.

Surface water flows are generally form the north (15m AHD) to the south, south east and south west towards the wetlands/floodplain of the Collie River. The major surface water features are the wetlands located in the lower lying areas. As the wetlands are seasonally inundated or waterlogged, the presence of standing water is likely to be an expression of ground water table rather than a function of surface run-off.

There is some connectivity between the areas of standing water through small vegetated creek line areas, which do not carry water outside the winter months. The Collie River runs along the southern boundary of the Structure Plan area. It is approximately 20m in width at the location of the Structure Plan and transports storm water from a large upstream catchment prior to discharging into the Leschenault Estuary.

2.4 Flood Prone Land

The Collie River runs along the southern boundary of the structure plan area. As part of the environmental assessment of the site and the determination of appropriate foreshore setback requirements the 1 in 100 year flood level has been mapped and included in the assessment as undertaken by Bio Diverse Solutions (appendix 2). Subsequently this has been determined to be contained within the Foreshore Area.

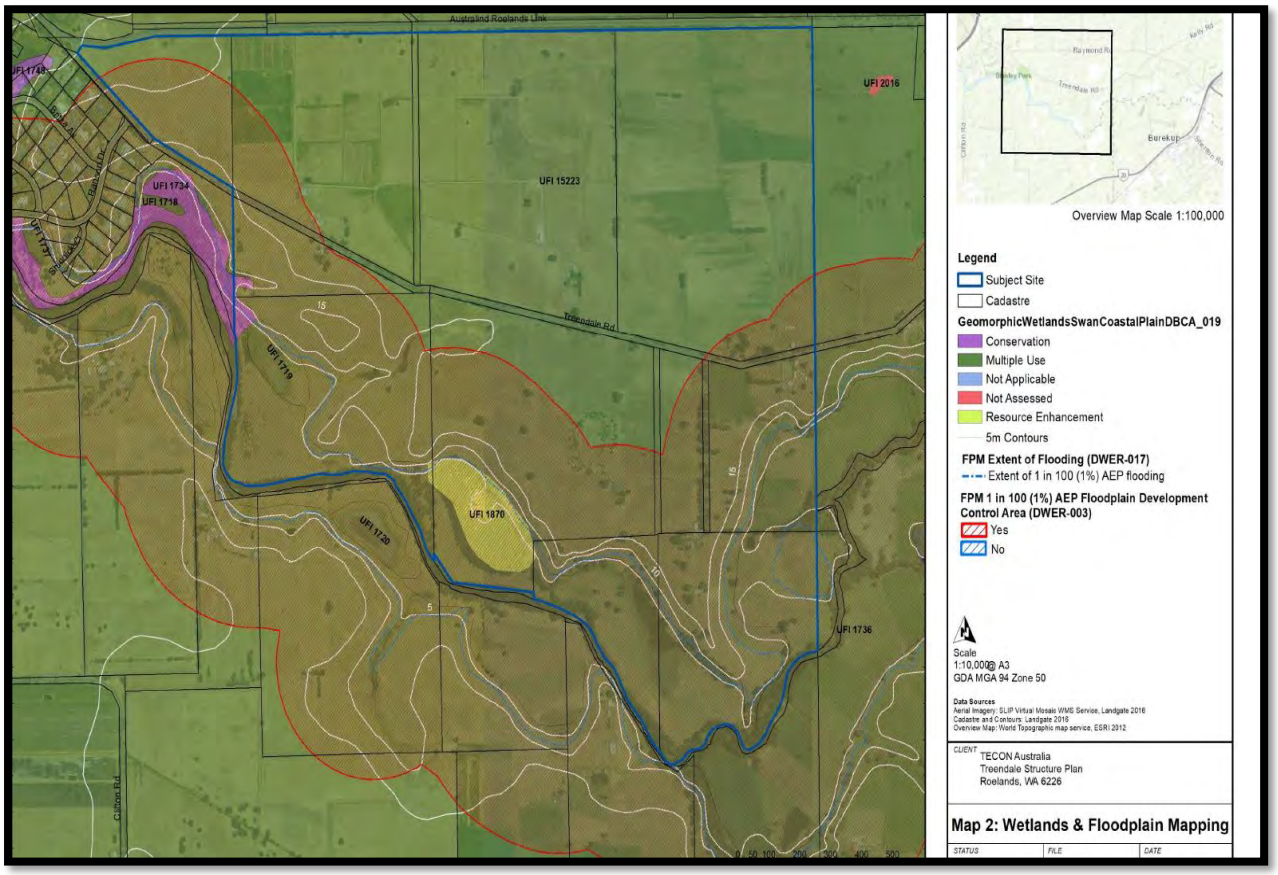

Figure 7: Wetland and Floodplain Mapping

2.5 Bushfire Hazard

The site has been identified as bushfire prone on Department of Fire and Emergency Services (DFES) bushfire prone area maps.

A Bushfire Management Plan has been prepared for the Structure Plan area (Bio Diverse Solutions 2020) appendix 3. The site is partially located within a designated bush fire prone area, however the assessment of bushfire risk is that the risk is manageable with the implementation of the documented actions.

The subject site was assessed as having internal areas of Forest Type A, Woodland Type B, Grassland Type G and Non-vegetated areas. The assessed bushfire risk is considered manageable and can be achieved by the relevant bushfire management measures identified in the report being implemented.

The predominant vegetation within the subject site is Class G Grassland and it is expected that this vegetation can be managed in a low threat state to the extent that future dwellings will be able to achieve BAL-29 or lower.

Treendale Road, Raymond Road and the construction of an internal road network will provide the development with safe access and egress to different locations.

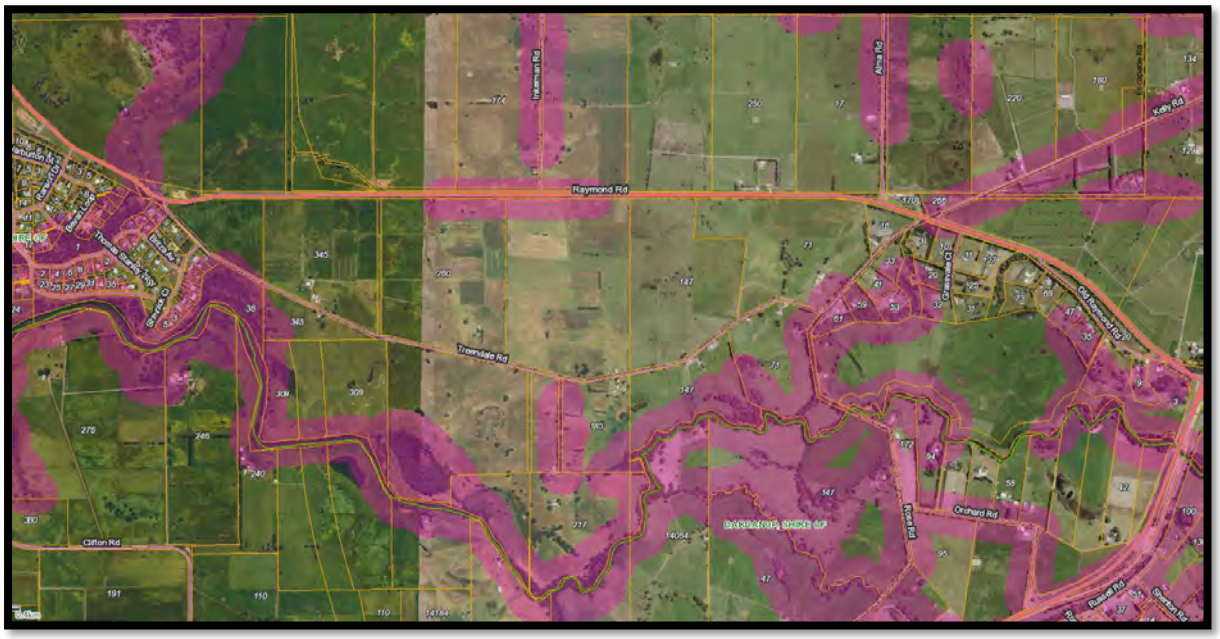

Figure 8: DFES Bush Fire Prone Map

2.6 Heritage

There are no specific Aboriginal or European heritage values identified throughout the Structure Plan area with the exception of the Collie River Wagul which occurs within the south of the project area and is listed a mythological, natural feature, water source site.

2.7 Public Health

The location of the site is within a mosquito breeding and mosquito borne disease risk area. A condition of subdivision approval is to submit a mosquito-borne disease and nuisance risk assessment and management plan. Similarly a condition of subdivision approval requires a notification on certificate of title, advising purchasers of the mosquito breeding areas and risks.

3.0 LANDUSE AND SUBDIVISION REQUIREMENTS

3.1 Design Principles

Structure Planning has previously been undertaken for land east of the Meadow Landing locality, including the subject land, creating a corridor between the existing development of Meadow Landing and the "Special Rural" development at the eastern end of Raymond Road.

The Local Structure Plan provides for rural residential development in a layout that responds to the following:

- The 1:100 flood level boundary.
- The alignment and reservation of the Bunbury Outer Ring Road.
- Environmental considerations including development exclusion areas.

Stage One Concept has been the subject of detailed studies inclusive of Wetland and Foreshore studies, Bushfire Management and servicing and infrastructure studies to enable foreshore boundaries and setbacks to be established to enable a concept design to be prepared and a lot yield estimated.

The structure plan proposes an estimated yield of 135 lots of one hectare minimum in Stage One appendix 4 demonstrates a Concept Design layout.

3.2 Foreshore Reserve

As presented by the Biodiverse Wetland Management Plan (appendix 2) the recommended buffers to wetlands as per the below table.

50m buffers have been applied from the mapped (DBCA dataset) edges of UFI 1734, 1870, 1736 and 1719 and will become future foreshore reserve.

Table 8: Proposed Wetland Buffers

UFI	Management Category	Buffers from mapped wetland edges
1734	Conservation	50m
1870	Resource Enhancement	50m
1736	Multiple Use	50m to development footprint. 30m associated with wedge of vegetation along the eastern boundary
1719	Multiple Use	50m
15223	Multiple Use	30m associated with wetland and creek/drainage line

Table 2: Proposed Wetland Buffers

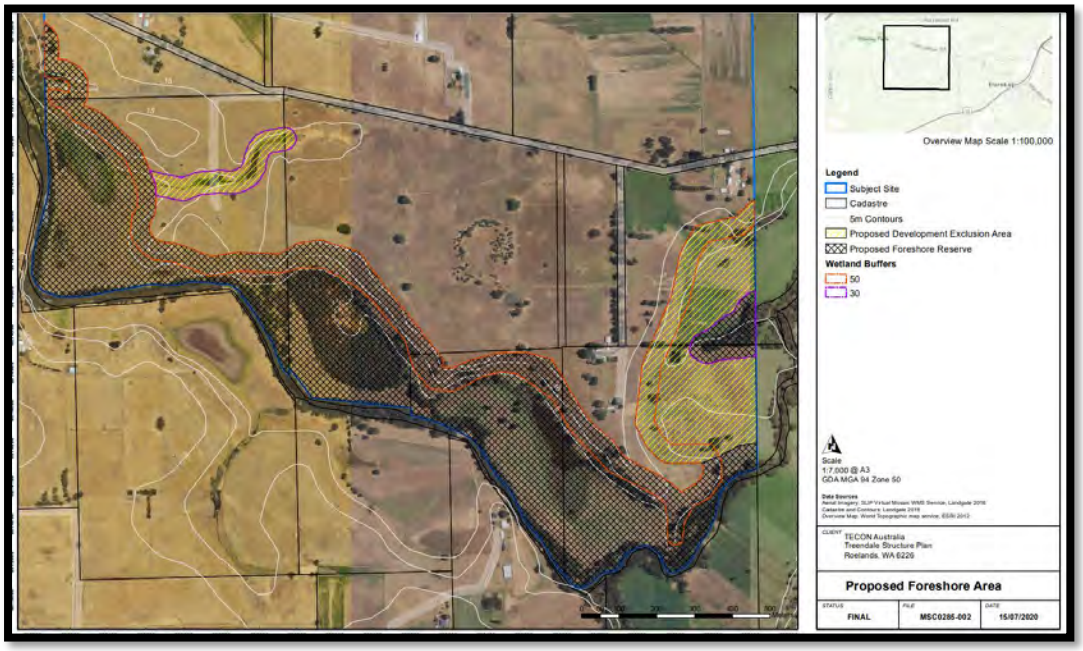

Figure 9: Proposed Foreshore Area

3.3 Rural Residential

The *Planning and Development (Local Planning Schemes) Regulations 2015* has sort to standardise the names of zones used in schemes by Local Governments. In order to be consistent with the terminology used in the LPS Regulations it is proposed to rename what is currently referred to in the Shire of Harvey Local Planning Scheme No.1 as 'Special Rural' to 'Rural Residential'.

Rural Residential developments have historically been attractive due to the lifestyle options they provide.

Rural Residential lots generally have a minimum lot size of 1ha.

3.4 Access and Movement

The study area is impacted by the alignment of the Bunbury Outer Ring Road (BORR) including a grade separated interchange with Raymond Road. The Structure Plan and concept design have been designed utilising the current alignment of the BORR as designed by MRWA.

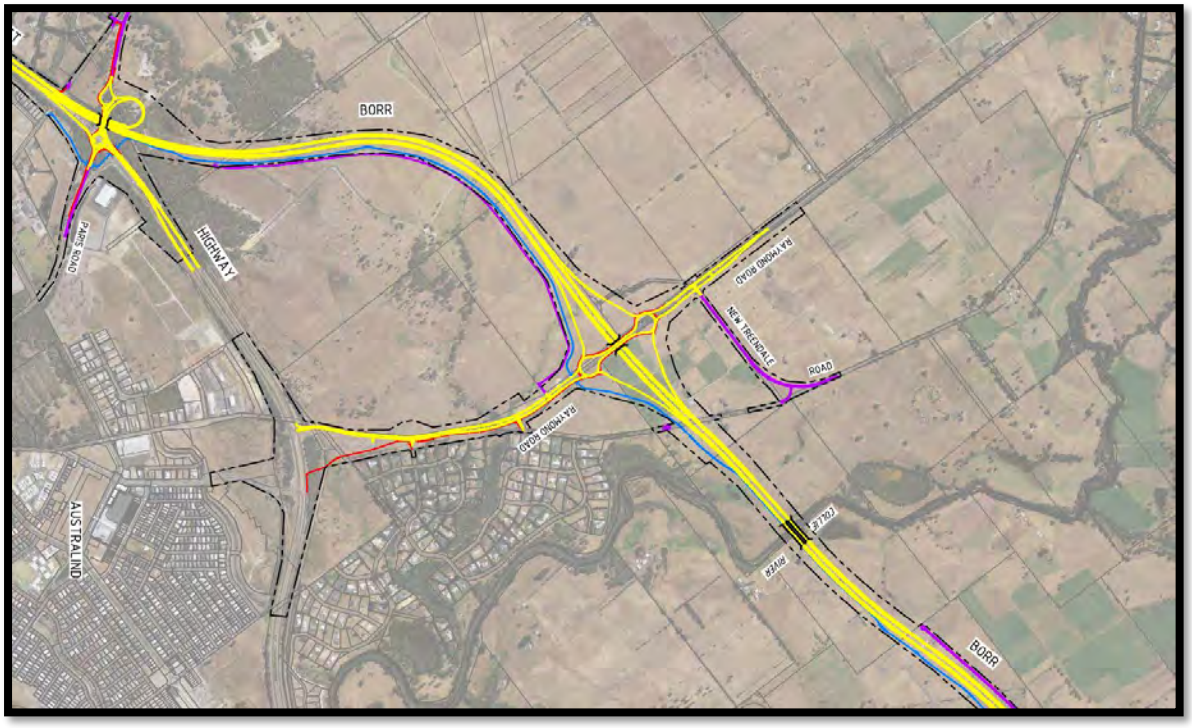

Figure 10: BORR Northern and Central Overall Plan

The proposed access to the development will be from Raymond Road. This is a Main Roads WA (MRWA) owned asset and as such the new access intersection will require their approval.

The existing Treendale Road will form a major part of the development access. The proposed BORR will cut off access to the Western end of Treendale Road from within the development when

constructed. The internal roads including Treendale are under the jurisdiction of the Shire of Harvey and any proposed road cross section will require their approval.

Typically for residential roads the Shire of Harvey would require a 6m wide 25mm AC7 asphalt sealed surface with kerbing.

There is clayey material close to the surface and as such an improved subgrade layer of granular, free draining material may be required within the development. The use of subsoil drainage may also be required. These requirements will be further clarified during the detailed engineering design phase. Due to the large lots and rural setting it is not anticipated that the Shire of Harvey is going to require footpaths to be installed within the proposed development.

3.5 Provision of Infrastructure

The below outlines existing services within the immediate area along with the likely service requirements for the development.

3.5.1 Water Supply

According to Water Corporation's Esinet system the nearest viable connection is located at the intersection of Treendale and Ranson Drive. The 150mm diameter main will require to be checked for capacity to service the proposed lots as it runs the length of Ranson Drive servicing lots within Meadow Landings.

Should the 150mm not have the capacity, the developer will likely be required at their own cost to extend the 200mm main located at the intersection of Raymond Road and Ranson Drive to the development to allow for water services to the lots.

Harvey Water owned irrigation channels are present along Treendale Road. These channels are also connected to channels within the local privately owned farmland and work to irrigate and drain the land.

3.5.2 Waste Water

There is currently no reticulated sewer within the area of the proposed development. Given the proposed larger lots, it is not anticipated that a reticulated sewer system will be required. Rather, on-site sewer units are expected on each individual lot.

3.5.3 Stormwater

On site stormwater management will be required within the development. The most logical drainage strategy for the development is to drain all stormwater towards the Collie River to the south and to have any water retention structures located within the lower areas in close proximity to the river.

An Urban Water Management Plan will be required as a condition of subdivision.

3.5.4 Earthworks

With the large lots that are proposed within structure plan area it is not envisaged that bulk earthworks or filling will be required.

3.5.5 Power and Communications

Power services will require extension from existing power mains located within Meadow Landing. These will require extension through Treendale Road to the development. Western Power may require two power extensions to maintain a ring main system for the development.

There are existing overhead lines that traverse the site that are likely to have to be relocated.

Communications services along Raymond Road are insufficient to service the new development and as such existing communications services within Meadow Landing will require extension.

4.0 TECHNICAL APPENDICIES INDEX

Appendix No.	Document	Summary	Approval Authority	Status
2	Wetland Management Final 12 August 2022	WMP to guide Structure Plan and determine wetland and foreshore areas applicable to Stage 1.	DBCA, DWER, DOW	Approved
3	Bushfire Management Plan 9 March 2023	BMP to guide all future bushfire management measures applicable to Stage 1.	Shire of Harvey	Approved
7	Local Water Management Strategy 2 August 2022	LWMS to guide the Structure Plan and subsequent stages of subdivision	DWER, Shire of Harvey	Approved
8	Site Soil Evaluation 2 August 2022	SSE to guide structure plan and future subdivision	Dept of Health	Approved

Table 3: Technical Appendices Index

APPENDICIES

APPENDIX 1

WESTERN AUSTRALIA

REGISTER NUMBER	
1/D5120	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

VOLUME 1003 FOLIO 348

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 1 ON DIAGRAM 5120

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

MELISSA JANE MCINTYRE OF 27 PORTOFINO CRESCENT, PELICAN POINT

(T M094343) REGISTERED 5/11/2012

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. *M094344 MORTGAGE TO COMMONWEALTH BANK OF AUSTRALIA REGISTERED 5/11/2012.
2. *O251145 NOTICE OF INTENTION TO TAKE FOR THE DESIGNATED PURPOSE OF BUNBURY OUTER RING ROAD (BORR) - NORTHERN AND CENTRAL SECTIONS. AS TO PORTION ONLY REGISTERED 3/10/2019.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	1003-348 (1/D5120)
PREVIOUS TITLE:	792-86
PROPERTY STREET ADDRESS:	260 TREENDALE RD, ROELANDS.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF HARVEY

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING M94344
NOTE 2: O379771 DEPOSITED PLAN 418093 LODGED

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WESTERN AUSTRALIA

REGISTER NUMBER	
3315/DP251811	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	25/2/2014

VOLUME 1009 FOLIO 749

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 3315 ON DEPOSITED PLAN 251811

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

COLLIE RIVER INVESTMENTS PTY LTD OF 320 LORD STREET, PERTH

(T M514057) REGISTERED 7/1/2014

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. THE LAND THE SUBJECT OF THIS CERTIFICATE OF TITLE EXCLUDES ALL PORTIONS OF THE LOT DESCRIBED ABOVE EXCEPT THAT PORTION SHOWN IN THE SKETCH OF THE SUPERSEDED PAPER VERSION OF THIS TITLE.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
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----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	1009-749 (3315/DP251811)
PREVIOUS TITLE:	534-62
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF HARVEY

NOTE 1: A000001A LAND PARCEL IDENTIFIER OF WELLINGTON LOCATION 3315 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 3315 ON DEPOSITED PLAN 251811 ON 24-MAY-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.

NOTE 2: THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.

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WESTERN AUSTRALIA

REGISTER NUMBER	
314/DP246083	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	24/2/2009

VOLUME 1405 FOLIO 876

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 314 ON DEPOSITED PLAN 246083

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

COLLIE RIVER INVESTMENTS PTY LTD OF 320 LORD STREET, PERTH

(T K822585) REGISTERED 12/1/2009

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. K849485 MORTGAGE TO BANK OF WESTERN AUSTRALIA LTD REGISTERED 10/2/2009.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	1405-876 (314/DP246083)
PREVIOUS TITLE:	422-34
PROPERTY STREET ADDRESS:	217 TREENDALE RD, ROELANDS.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF HARVEY

NOTE 1:	A000001A	LAND PARCEL IDENTIFIER OF WELLINGTON LOCATION 314 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 314 ON DEPOSITED PLAN 246083 ON 19-APR-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.
NOTE 2:		THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.
NOTE 3:	M735960	CORRECTION MADE ON ORIGINAL CERTIFICATE OF TITLE - BUT NOT SHOWN ON CURRENT EDITION OF THE DUPLICATE

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WESTERN AUSTRALIA

REGISTER NUMBER	
246/DP232718	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	24/2/2009

VOLUME 1405 FOLIO 877

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 246 ON DEPOSITED PLAN 232718

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

COLLIE RIVER INVESTMENTS PTY LTD OF 320 LORD STREET, PERTH

(T K822585) REGISTERED 12/1/2009

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. K849485 MORTGAGE TO BANK OF WESTERN AUSTRALIA LTD REGISTERED 10/2/2009.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
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----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

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SKETCH OF LAND:	1405-877 (246/DP232718)
PREVIOUS TITLE:	422-33
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF HARVEY

NOTE 1: A000001A LAND PARCEL IDENTIFIER OF WELLINGTON LOCATION 246 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 246 ON DEPOSITED PLAN 232986 ON 19-APR-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.

NOTE 2: THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.

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WESTERN AUSTRALIA

REGISTER NUMBER	
878/DP251812	
DUPLICATE EDITION **2**	DATE DUPLICATE ISSUED **9/9/2020**

VOLUME **1475** FOLIO **315**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 878 ON DEPOSITED PLAN 251812

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

COMMISSIONER OF MAIN ROADS OF WATERLOO CRESCENT EAST PERTH WA 6004
(T O479438) REGISTERED 25/8/2020

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. *O251145 NOTICE OF INTENTION TO TAKE FOR THE DESIGNATED PURPOSE OF BUNBURY OUTER RING ROAD (BORR) - NORTHERN AND CENTRAL SECTIONS. AS TO PORTION ONLY REGISTERED 3/10/2019.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
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----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

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SKETCH OF LAND:	1475-315 (878/DP251812)
PREVIOUS TITLE:	123-23
PROPERTY STREET ADDRESS:	345 TREENDALE RD, ROELANDS.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF HARVEY
RESPONSIBLE AGENCY:	MAIN ROADS WESTERN AUSTRALIA

NOTE 1: O379480 DEPOSITED PLAN 418092 LODGED

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WESTERN AUSTRALIA

REGISTER NUMBER	
100/DP68088	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	16/10/2014

VOLUME 2806 FOLIO 419

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 100 ON DEPOSITED PLAN 68088

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ROBERT LINDSAY TAYLOR OF 7 CORONATION DRIVE, BINNINGUP

(T M795864) REGISTERED 14/10/2014

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. C788466 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE DEPOSITED PLAN 68088 REGISTERED 8/6/1984.
   *H510366 NOTIFICATION. THE GRANTEES OF EASEMENT C788466 ARE NOW ALINTAGAS NETWORKS PTY. LTD. PURSUANT TO SECTION 16 OF THE GAS CORPORATION (BUSINESS DISPOSAL) ACT 1999. REGISTERED 25/7/2000.
2. *O251145 NOTICE OF INTENTION TO TAKE FOR THE DESIGNATED PURPOSE OF BUNBURY OUTER RING ROAD (BORR) - NORTHERN AND CENTRAL SECTIONS. AS TO PORTION ONLY REGISTERED 3/10/2019.
3. *O558782 CAVEAT BY COMMISSIONER OF MAIN ROADS AS TO PORTION ONLY LODGED 19/11/2020.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
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SKETCH OF LAND: DP68088
PREVIOUS TITLE: 2513-822
PROPERTY STREET ADDRESS: NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY: SHIRE OF HARVEY

NOTE 1: O379162 DEPOSITED PLAN 418090 LODGED
NOTE 2: O445194 DEPOSITED PLAN (INTEREST ONLY) 419119 LODGED

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WESTERN AUSTRALIA

REGISTER NUMBER	
157/DP418094	
DUPLICATE EDITION **N/A**	DATE DUPLICATE ISSUED **N/A**

VOLUME **2983** FOLIO **347**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 157 ON DEPOSITED PLAN 418094

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

CRYSTAL RIVER INVESTMENTS PTY LTD OF 320 LORD STREET, PERTH

(AF O422189) REGISTERED 9/6/2020

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. *K851314 MORTGAGE TO BANK OF WESTERN AUSTRALIA LTD REGISTERED 17/3/2009.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	DP418094
PREVIOUS TITLE:	1578-708
PROPERTY STREET ADDRESS:	309 TREENDALE RD, ROELANDS.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF HARVEY

NOTE 1: O422189 THIS LOT/TITLE CREATED AFTER PORTION OF THE LAND TAKEN FROM THE FORMER LOT WITHOUT PRODUCTION OF THE DUPLICATE TITLE BY TAKING ORDER O422189. CURRENT DUPLICATE FOR THE WITHIN LAND IS STILL VOL 1578 FOL708 EDITION 2

LANDGATE COPY OF ORIGINAL NOT TO SCALE 10/12/2020 01:17 PM Request number: 61382058

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
510/DP418094	
DUPLICATE EDITION **N/A**	DATE DUPLICATE ISSUED **N/A**

VOLUME **2983** FOLIO **348**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 510 ON DEPOSITED PLAN 418094

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

COMMISSIONER OF MAIN ROADS OF PO BOX 6202 EAST PERTH WA 6892

(AF O422189) REGISTERED 9/6/2020

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. *O422189 TAKING ORDER. THE DESIGNATED PURPOSE OF BUNBURY OUTER RING ROAD-NORTHERN AND CENTRAL SECTIONS. REGISTERED 9/6/2020.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	DP418094
PREVIOUS TITLE:	1578-708
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF HARVEY
RESPONSIBLE AGENCY:	MAIN ROADS WESTERN AUSTRALIA

NOTE 1: O422189 NO DUPLICATE TITLE ISSUED.

LANDGATE COPY OF ORIGINAL NOT TO SCALE 10/12/2020 01:17 PM Request number: 61382058

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
N/A	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	23/3/2009

VOLUME 792 FOLIO 87

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

THIS IS A MULTI-LOT TITLE

LAND DESCRIPTION:

LOT 2 ON DIAGRAM 5120
LOT 3 ON DIAGRAM 5500

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

CRYSTAL RIVER INVESTMENTS PTY LTD OF 320 LORD STREET, PERTH

(T K851313) REGISTERED 17/3/2009

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. K851314 MORTGAGE TO BANK OF WESTERN AUSTRALIA LTD REGISTERED 17/3/2009.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	792-87 (2/D5120), 792-87 (3/D5500)
PREVIOUS TITLE:	534-62, 792-86
PROPERTY STREET ADDRESS:	185 TREENDALE RD, ROELANDS (3/D5500).
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF HARVEY

LANDGATE COPY OF ORIGINAL NOT TO SCALE 10/12/2020 01:16 PM Request number: 61382058

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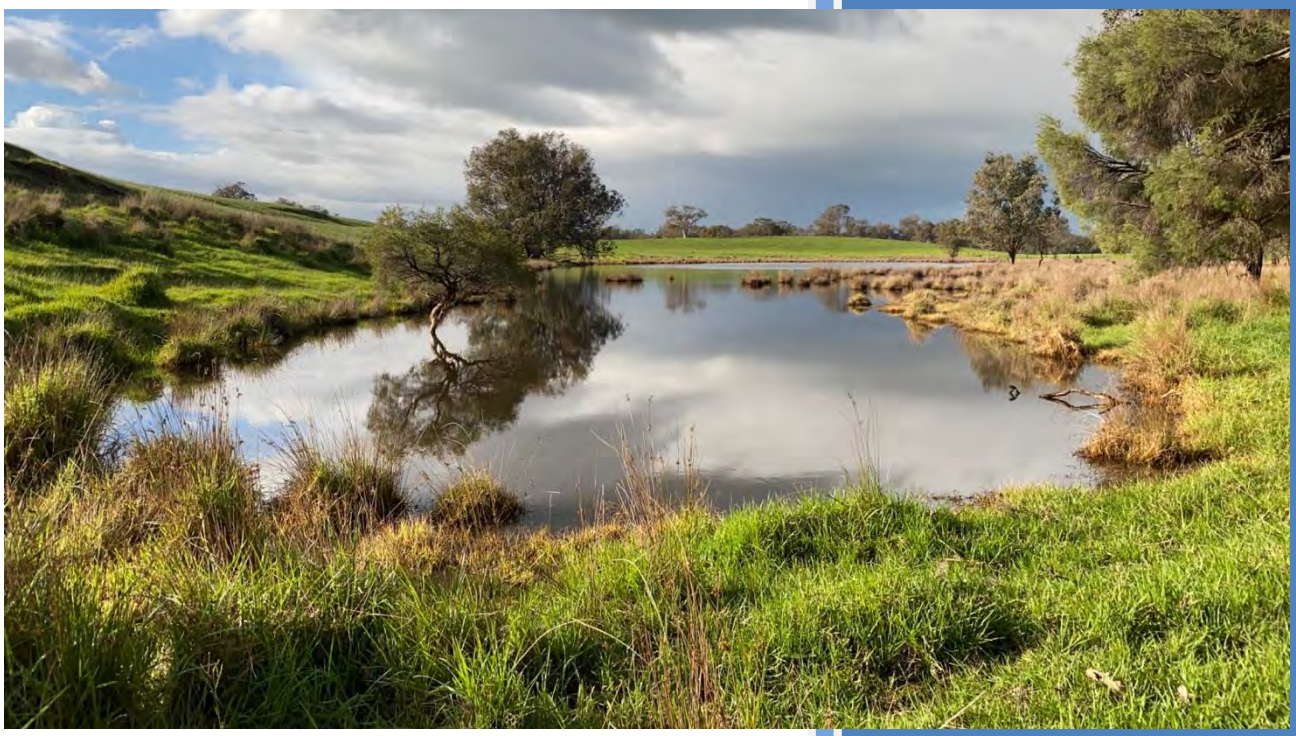
APPENDIX 2

Treendale Structure Plan

Area 3B

Wetland Management Plan



BIO DIVERSE SOLUTIONS

Bio Diverse Solutions

FINAL v.5

12/08/2022

DOCUMENT CONTROL

Report Title: Treendale Structure Plan Area 3B – Wetland Management Plan
Author (s): Bianca Theyer and Chiquita Cramer
Reviewer (s): Kathryn Kinnear, Kristy Richardson, M. Holt
Job No.: MSC0285
Client: TECON Australia

REVISION RECORD

Revision	Summary	Prepared By	Reviewed By	Date
Draft V.1 27/07/2020	Internal QA and input into Hydrology sections	B. Theyer	C. Cramer	28/07/2020
Draft V.2 29/07/220	Internal QA	B. Theyer	K. Kinnear	31/07/2020
Draft v. 3 31/07/2020	Updates from internal QA and submitted to client for review.	B. Theyer	K. Kinnear	31/07/2020
Draft v. 4 24/09/2020	Updates to report as per client review and issued to client	B. Theyer	K. Kinnear	24/09/2020
Draft v. 4 2/10/2020	Updates to mapping with newly provided .dwg	B. Theyer	K. Kinnear	2/10/2020
Draft v. 5 8/12/2020	Minor updates as per requests from client upon discussions with LGA.	B. Theyer	K. Kinnear	8/12/2020
Draft v.6 9/08/2022	Updated with most recent Structure Plan	C. Cramer	M. Holt	9/08/2022
Final v.1 12/08/22	Final version 1 submitted to client	C. Cramer	-	12/08/22

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ABN 46 643 954 929

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1. Introduction

TECON Australia commissioned Bio Diverse Solutions to prepare a Wetland Management Plan (WMP) to guide a proposed Structure Plan (SP) at lots or part of lots 1, 2, 3, 121, 185, 246, 314 and 3315 Treendale Road, Roelands herein referred to as the "Subject Site". The "Survey Area" described within this report includes the wetland areas to the south and southwest of the SP area. This area is associated with Lots 121, 3315, 246, 3 and 314 (refer to Figure 1).

This document outlines the desktop analysis and field searches undertaken to assess the wetlands on site, provides an inventory of vegetation and flora species, and provides guidance for the SP and subsequent subdivision and development of the site. This report is in accordance with the Department of Biodiversity and Attractions (DBCA) (previously Department of Environment and Conservation, DEC) Guidelines checklist for preparing a wetland management plan (DEC, 2008).

The Survey Area includes within its boundary five Geomorphic Wetlands (refer to Table 3), including the Collie River which is situated along the southern boundary of the Survey Area. Three of the mapped wetlands are "Multiple Use", one is classed as "Resource Enhancement" and one is classed as "Conservation". There is one Environmentally Sensitive Area (ESA) that extends within the Survey Area along the western boundary, this is associated with the Conservation wetland; UFI 1734.

A portion of the Survey Area to the southwest of the SP area is within the currently being constructed Bunbury Outer Ring Road (BORR). Plans and construction drawings for the BORR were not available at the time of the field survey, which is why the wetlands within and to the west of the BORR boundary have been included as part of the Survey Area. Management strategies for the wetlands within the BORR boundary should be discussed within the environmental reporting for the BORR and are not discussed within this report.

1.1. Alignment to Legislation, Policy and Guidelines

Bio Diverse Solutions has prepared this report aligned to the following legislation, please refer to Table 1 below.

Table 1: Government Legislation Applicable to the Proposal.

Legislation	Responsible Government Agency	Aspect
Biosecurity and Agriculture Management Act 2007	Department of Agriculture and Food	Weeds and feral pest animals
Conservation and Land Management Act 1984	Department of Biodiversity, Conservation and Attractions	Wetlands/Flora and fauna / habitat /weeds / pests / diseases
Environmental Protection Act 1986 (Part IV)	Environmental Protection Authority	Assessment and Management Environmental Impact
Environmental Protection (Clearing of Native Vegetation) Regulations 2004	Department of Water and Environmental Regulation	Clearing of native vegetation
Soil and Land Conservation Act 1945	Department of Primary Industries and Regional Development	Protection of soil resources
Biodiversity Conservation Act 2016 Wildlife Conservation Act 1950	Department of Biodiversity, Conservation and Attractions	Protection of indigenous wildlife
The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).	Department of Agriculture, Water and the Environment	Protection of Vulnerable and Threatened species of national significance
Aboriginal Heritage Act 1972 (AH Act)	Department of Aboriginal Affairs (Western Australia)	Protection of aboriginal heritage sites

Bio Diverse Solutions has prepared this report aligned to the following guidelines and policies:

- Attachment B4-5 in Environmental Guidance for Planning and Development – Guidance Statement 33 (EPA, 2008);
- Guidelines Checklist for Preparing a Wetland Management Plan (DEC 2008);
- Guideline for the Determination of Wetland Buffer Requirements (WAPC 2005); and
- Operational policy 4.3: Identifying and establishing waterways foreshore areas (DoW, 20212).

This WMP has been written in reference to the following documents that have been prepared for the Structure Plan and these should be read in conjunction with this report:

- Environmental Assessment and Land Capability Study, Prepared by Cardno BSD Pty, 2006; and
- Environmental Assessment Report Treendale Road, Prepared by 360 Environmental 2016.

1.2. Site location

The Survey Area is 17 km north east of the Bunbury Central Business District (CBD), and is within the locality of Roelands, within the municipality of the Shire of Harvey. The future Bunbury Outer Ring Road (BORR) is proposed immediately west of the Subject Site and transects the Survey Area in the west. Please refer to Figure 1 below - Locality Map. A copy of the proposed Structure Plan is provided in Appendix A.

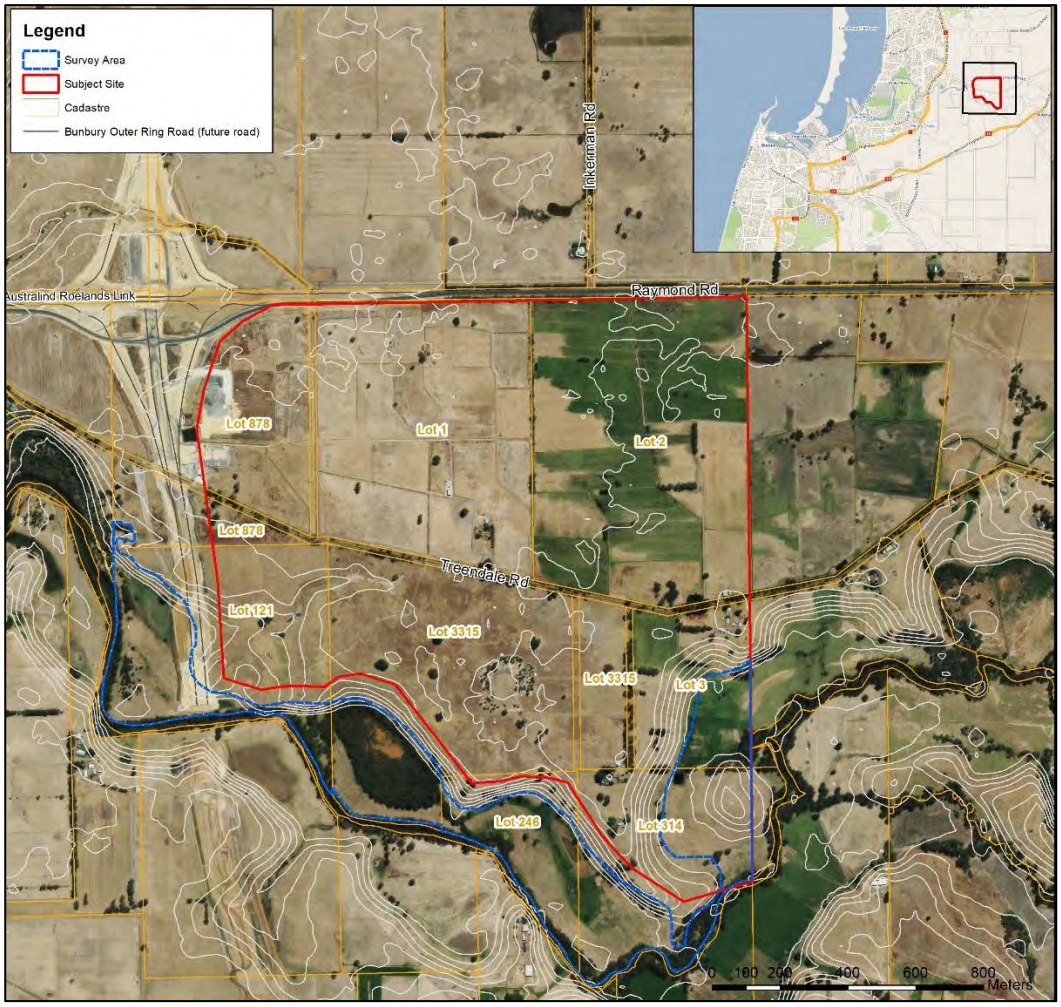


Figure 1: Locality Map.

1.3. Infrastructure

The Subject Site is approximately ~215ha and consists of predominantly paddocks. The Survey Area is ~53 ha in size with some remaining native vegetation within wetlands and along the Collie River fringes. There are three existing dwellings and associated farm infrastructure (sheds, cattle yards, troughs and tanks) within the Subject Site. There are large open paddocks with cattle grazed within both the Subject Site and the Survey Area, with no fencing around the internal wetland areas.

1.4. Planning Background

The Landholdings are within the 1996 Treendale Structure Plan (Policy Area 3B – 1996 Structure Plan) which was endorsed by the WAPC in February 1996 and applies to a number of properties between Raymond Road and the Collie River. The Landholdings have been designated under the 1996 Structure Plan for future rural residential development.

The Department of Planning, Lands and Heritage (DPLH) has considered the status of the 1996 Structure Plan and has determined that the Plan has full legal effect as a document to be given due regard in any decision making.

In noting the status of the 1996 Structure Plan and the advice from DPLH that the 1996 Structure Plan has full legal affect there is still a need to amend the document to address the implications of the Bunbury Outer Ring Road (BORR) as well as comprehensively addressing environmental and engineering servicing considerations.

The Amended Structure Plan will provide the framework for the coordinated provision and arrangement of the land uses, subdivision and development. It will also inform the provision of a transport network, public open space, public utilities, development standards, community infrastructure and urban water management.

The Amended Structure Plan will be prepared consistent with the WAPC Structure Plan Preparation Guidelines and based on advice from the Shire of Harvey and DPLH the studies required to be completed are as follows:

(i) Civil Engineering in the areas of stormwater management, utility services and acid sulphate soils;
(ii) Environmental study in regards to foreshore setbacks and management plans;
(iii) Bush Fire Management; and
(iv) Amendment of the associated transport network to facilitate the proposed BOOR alignment.

1.5. Purpose and Scope

A search of the Geomorphic Wetlands Swan Coastal Plain Dataset was undertaken revealing five Geomorphic Wetlands within the Subject Site / Survey Area. Geomorphic wetlands are assigned 3 Conservation Management Categories, please refer to Table 2.

Table 2: Geomorphic Wetland Management Categories (DBCA, 2020).

Management Category	General Description	Management Objectives
Conservation	Wetlands which support a high level of attributes and functions.	Highest priority wetlands. Objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including: • Reservation in national parks, crown reserves and State-owned land. • Protection under Environmental Protection Policies. • Wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions.	Priority wetlands. Ultimate objective is to manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category. This can be achieved by restoring wetland function, structure and biodiversity. Protection is recommended through a number of mechanisms.
Multiple Use	Wetlands with few remaining important attributes and functions.	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare.

Key wetlands were identified as significant features to be protected as part of the design process of the Structure Plan. The mapped geomorphic wetlands (Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)) within the Survey Area included are described below in Table 3 and shown in Map 2 (Appendix A). The scope of the work undertaken by Bio Diverse Solutions was to focus on the wetlands that may be directly impacted by the proposed development within the Subject Site. In addition, assess the creek / drainage line within UFI 15223 (to the east of UFI 1719).

Table 3: Geomorphic Wetlands Identified.

UFI	Management Category	Description	Location
1734	Conservation	Flat, Floodplain Seasonally inundated.	North western corner of the survey area. Located to the south of Treendale Road. Adjacent to UFI 1719. Majority of this wetland extends outside of the Subject Site.
1870	Resource Enhancement	Basin, Sumpland Seasonally inundated.	Located south central of the Subject Site / Survey Area, adjacent to the Collie River.
1736	Multiple Use	Flat, Floodplain Seasonally Inundated.	Southern boundary of the Subject Site / Survey Area (Collie River).
1719	Multiple Use	Basin Sumpland Seasonally inundated.	North western corner of the Survey Area. Located to the south of Treendale Road. Adjacent to UFI1734.
15223	Multiple Use	Flat, Palusplain Seasonally waterlogged.	Covers the Subject Site (excepting other wetlands). Extends outside of the Subject Site and covers surrounding properties.

2. Summary of Management Commitments

2.1. Vision

To ensure the wetlands identified within this plan are conserved and rehabilitated for future ecological values.

2.2. Purpose

The purpose of this WMP is to ensure protection and enhancement of the primary values and functions of the wetlands within the Survey Area in line with the following objectives:

- Protecting native vegetation in the wetlands;
- Protecting and enhancing the fauna habitat values of the area;
- Maintaining the existing hydrology of the wetlands;
- Maintaining the water quality of the wetlands and the groundwater;
- Controlling invasive weeds in the wetlands;
- Rehabilitating degraded areas to enhance the amenity of the wetlands;
- Providing buffers that will protect the wetlands;
- Providing appropriate levels of public access in and around the wetland buffers to enable community interaction with the environment whilst maintaining wetland values; and
- Managing construction impacts on the wetland.

2.3. Wetland Values

Values of a wetland are considered in terms of their regional context, ecosystem value and their human use value in accordance with to the EPA"s Guidance Statement No. 33 (Environmental Protection Authority 2008).

2.4. Ecosystem Values

The wetlands are seasonally inundated or seasonally waterlogged, with large areas of standing water and areas of inundation in winter wet periods. During the site assessment there were two standing bodies of water within the Survey Area, one being wetland UFI 1719 the other is an area associated with wetland UFI 1736 (Map 2, Appendix A). There is also a small body of water to the west of UFI 1719 that is associated with UFI 15223. It is likely that these areas dry out in the warmer summer months and that the summer standing water is a surface expression of the groundwater table. The wetlands are likely to provide drought refuge for waterbirds or summer feeding areas for wading birds. The "dry" wetland areas provide habitat for invertebrate fauna which in turn support frogs, lizards, snakes, birds and mammals.

2.5. Human Use Values

Social functions pertaining to wetlands are related to recreation and appreciation / amenity. Recreation includes active recreation or passive types such as bird watching, walking and nature studies. The degraded nature of the wetlands has resulted from current land use activities, in particular cattle grazing.

As part of the design process for the site, the Geomorphic wetlands within the Survey Area (excluding UFI15223) were identified as significant features to be protected and a series of buffers and revegetation strategies are offered as well as possible Public Open Space (POS) opportunities. While the wetlands provide landscape amenity to surrounding residents, the buffers associated with the Geomorphic wetland areas, will provide passive recreation opportunities (walking, cycling, running, nature watching) through the provision of a paths network and the opportunity for interpretative signage relating to the biodiversity of the wetlands and aboriginal heritage.

2.6. Community, Stakeholder and Adjacent Landowner Engagement

To date no community groups have been consulted as part of this Wetland Management Plan, however consultation has occurred by TECON Australia to the Local Authority and neighbours on other issues pertinent to the site. Landowners on the defined Structure Plan have been contacted in relation to the project. Those landowners that have not funded the project will be kept up to date however they won't receive copies of the reports until they are made available during the advertising process.

2.7. Strategies

Defined strategies are provided in Sections 6-18 of this document. These strategies outline specific actions over the long term and short term, priorities and agencies or group responsible for implementation.

2.8. Performance Criteria

Measurable targets for this WMP involve the successful rehabilitation of the wetlands within the Survey Area and the preservation of values of adjacent wetlands to the Survey Area.

3. Desktop Assessment

Desktop assessments were undertaken of government databases to ascertain environmental aspects both within the Subject Site / Survey Area and the surrounding area. This assessment was conducted to various levels, ranging from state-wide to area specific information and includes information on climate, geology and soils, environmentally sensitive areas, acid sulfate soils, public drinking water areas, water bodies and Aboriginal heritage.

3.1. Topography

The majority of the Subject Site lies within the 15m AHD contour line, declining through the southern portion of the site throughout the wetland / floodplain areas to 5m AHD. The topographic contours are shown in Map 2 (Appendix A).

3.2. Geology and Soils

Soil mapping – Best Available (DPIRD, 2020a) shows the Subject Site / Survey Area lies within the Pinjarra System (213Pj). The system is described as "Swan Coastal Plain from Perth to Capel. Poorly drained coastal plain with variable alluvial and aeolian soils. Variable vegetation includes Jarrah, marri, wandoo, paperbark sheoaks and rudis". The Pinjarra Zone (213) is described as having "Alluvial deposits (early Pleistocene to Recent) between the Bassendean Dunes Zone and the Darling Scarp, colluvial and shelf deposits adjacent to the Darling Scarp. Clayey to sandy alluvial soils with wet areas." (DPIRD, 2020a).

Soil testing was conducted at the Subject Site in 2006 (Cardno BSD, 2006). Cardno BSD (2006) details that the soil types found at the site consist of duplex soils with varying depths (0.2m – 0.7m) of pale quartz sand overlaying dense highly plastic clays in the northern portion of the Subject Site. Within the south east of the Subject Site soils were found to be red earths (to 1.3m) overlying hard packed yellow / orange and white / grey clay. Soils types in the southern floodplain areas were described as red/brown loamy earth (1.2m – 2.7m) overlying mottled grey / brown, orange / yellow or red/orange clays.

Site soil testing was also conducted on the 20th and 21st of September 2021 by Bio Diverse Solutions under late winter conditions. Testing involved site soil analysis, photographic recording, logging of soil types, measuring of water table, infield infiltration testing and laboratory PRI testing. In total, 27 test holes were constructed to a varying depths up to 2m. The 27 test pits revealed that soils across the Subject Site varied somewhat with site and topography, however generally soils across the Subject Site comprised of duplex soils of varying depths of sand overlaying sandy clay. The general soil profile found across the Subject Site comprised of:

- Silty sand / loam (topsoil): fine grained, well sorted, dark grey / brown, moist to dry, extending from the ground surface to depths of between 0.2 m and 0.4 m, overlying.
- Sand / clayey sand: fine grained, well sorted, grey to light grey, moist to saturated, extending from beneath the topsoil to depths generally between 0.4 and 0.6m BGL (this layer was only present through the central portion of the Subject Site, overlying.
- Sandy clay: fine grained sand, orange / brown. Plasticity of clay usually transitioned from low to medium with depth. This layer generally extended from ~0.4m depth where no sand / clayey sand layer was present to the depth of hole or from ~0.6m depth where the sand/clayey sand layer was present to the depth of hole.

BDS found areas adjacent to the Collie River within the Survey Area comprised of earthy loams, with soil profiles consisting of:

- Loam: fine grained, well sorted, dark brown, dry. Extending from the ground surface to depths of approximately 0.6m, overlying.
- Sandy clay loam: low plasticity, fine grained sand, red brown. Extending to the depth of hole at 2 metres.

3.3. Climate

The Roelands area is characterised by a Mediterranean climate with warm dry summers and cool wet winters. Rainfall data is from the nearby Bureau of Meteorology (BoM, 2021) Burekup Station (Site No. 9710).

The long-term average annual rainfall is 896mm (1905 to 2020). This average has decreased between 2000 to present, to an average annual rainfall of 807mm, reflecting a 10% reduction compared to the long-term average, consistent with a general trend in the South West of WA.

The total rainfall distribution has also altered, with a reduction of average winter monthly rainfall, but no significant reduction in average summer monthly rainfall.

The average annual pan evaporation for the Roelands area is approximately 1400mm (Luke et al 1988).

3.4. Acid Sulphate Soils

Acid sulphate soils (ASS) are naturally occurring soils and sediments containing sulphide minerals, predominantly pyrite (an iron sulphide). When undisturbed below the water table these soils are benign and not acidic (potential acid sulphate soils). However, if the soils are drained, excavated or exposed by lowering of the water table, the sulphides will react with oxygen to form sulphuric acid (EPA 2008).

Acid Sulphate Soil (ASS) Risk Mapping (DWER, 2017) indicates the Subject Site / Survey Area is within areas of both high to moderate risk and moderate to low risk. The moderate to low risk covers the majority of the Subject Site (cleared agricultural areas) whilst the high to moderate risk is situated within the Collie River wetland area (Survey Area).

3.5. Wetlands

The Subject Site and Survey area are located within the Leshenault Inlet Management Area which is designated as a Waterways Conservation Act Management Area (WALGA, 2020a).

The southern boundary of the Survey Area is bounded by the Collie River and the Collie River floodplain. The wetlands identified through the Geomorphic Wetlands dataset of the Swan Coastal Plain is presented in Map 2 in Appendix A. Three “Multiple Use” geomorphic wetlands cover the majority of the Survey Area (UFI 15223, 1736 and 1719) which are classified as palusplain, floodplain and sumplands respectively.

One “Conservation” wetland (UFI 1734) is located in the western portion of the Survey Area, this wetland is classed as a floodplain.

One “Resource Enhancement” wetland (UFI 1870) is located centrally within the Survey Area and is classed as a sumpland. Please refer to Map 2 in Appendix A.

As per the scope of this project a series of photographs and vegetation surveys were undertaken of the wetland areas (refer to Section 4).

3.6. Hydrology and Hydrogeology

3.6.1. Surface Water

The Subject Site is generally flat and as such the majority of stormwater ponds on site, either at surface or within agricultural drains that have been constructed across the site. Any discharge off the site north of Treendale Road is in a north westerly direction towards a seasonal creek line within agricultural land to the north west of the Subject Site. The seasonal creek ultimately discharges to the Collie River via a Conservation Category wetland further west of the Subject Site. Stormwater runoff from the site in the southern portion of the Subject Site is to the south towards the Collie River and the adjoining wetlands that are situated between the river and the Subject Site. The Collie River ultimately discharges to Leschenault Estuary to the west.

There are no major water bodies within the Subject Site. There are several manmade drains and farm dams within the site and one naturally formed seasonal creak line with a dammed upstream section in the southwest of the Subject Site. There are also some areas across the site that are subjected to seasonal inundation given the flat nature of the site and its close proximity to the Darling Range to the east, consequently receiving surface water runoff from range.

The Subject Site is located within the Coastal Plain hydrological zone (HZ15_CP) (DPIRD, 2018) and described as; ‘Coastal & fixed sand dunes & calcarenite. Non-calcareous sands, podsolised soils with low-lying wet areas. Further inland, alluvial deposits, colluvial *deposits adjacent to the Darling Scarp. Clayey to sandy alluvial soils with wet areas’.*

The Subject Site is also located within one hydrographic catchment being the Leschenault Estuary-Lower Collie Catchment and one hydrographic sub-catchment being the Lower Collie Tribs (DWER, 2018).

3.6.2. Groundwater

Groundwater was not encountered in any of the test pits (to a depth of 2-4 metres) during the assessment conducted by Cardno BSD in January 2006 on the Subject Site to the south of Treendale Road. While the soils at some locations were observed to be moist the water table was not encountered. Noting the Cardno BSD (2006) investigation was conducted in January when groundwater levels are expected to be below peak annual levels.

The test pits constructed by BDS on the 20th and 21st September 2021 showed a shallow (<0.5m BGL) perched groundwater table across much of the Subject Site.

Monthly groundwater monitoring (levels) was conducted from December 2016 to August 2017 by 360 Environmental at 7 groundwater monitoring locations within the area of the Subject Site south of Treendale Road. The monthly depth to groundwater measurement for each monitoring bore is presented in Table 4 and the location of the groundwater monitoring bores is shown in Map 2 (Appendix A).

Table 4: Groundwater monitoring levels Dec 16 to Aug 17 (360 Environmental).

Bore	Bore Depth (m)	Monitoring event								
		Dec-16 (m BGL)	Jan-17 (m BGL)	Feb-17 (m BGL)	Mar-17 (m BGL)	Apr-17 (m BGL)	May-17 (m BGL)	Jun-17 (m BGL)	Jul-17 (m BGL)	Aug-17 (m BGL)
MB1	6	5.11	5.33	5.21	5.06	5.63	5.88	6	5.76	3.54
MB2 shallow	6	dry	dry	dry	dry	dry	dry	dry	dry	dry
MB2 deep	20	5.39	12.16	12.29	12.35	12.45	12.46	12.44	12.3	11.63
MB3	6	dry	dry	dry	dry	dry	dry	dry	dry	3.15
MB4	6	dry	dry	dry	dry	dry	dry	dry	dry	4.95
MB5	6	4.9	4.8	5.05	5.23	5.55	5.76	5.89	5.52	2.13
MB6 shallow	6	dry	dry	dry	dry	dry	dry	dry	dry	3.75
MB6 deep	20	5.31	8.21	8.26	8.26	8.37	8.25	8.1	8	7.35
MB7	6	5.81	1.4	1.56	1	1.6	0.98	1.1	0.74	0.73

The surficial water table was evident at varying depths below ground level across the southern portion of the Subject Site. The highest recorded groundwater level was recorded at MB7 during August 2017, being 0.73m BGL, all other groundwater levels recorded across the site were greater than 2m BGL. No groundwater monitoring was conducted within the Survey Area.

3.7. Remnant Vegetation

The Survey Area lies within the SWA2 - Swan Coastal Plain Interim Bio-geographic Regional Area (IBRA bioregion). Mitchell et al (2002) describes the Swan IBRA region as: "low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, Casuarina obesa on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted *Mesozoic sediments dominated by Jarrah woodland."*

The vegetation has been mapped on a broad scale by J.S. Beard (Shepherd et al. 2002) in the 1970's, where a system was devised for state-wide mapping and vegetation classification based on geographic, geological, soil, climate structure, life form and vegetation characteristics (Sandiford and Barrett, 2010). Vegetation units were regarded as associations and were grouped into Vegetation Systems representing a particular pattern of association distribution within a given area. A GIS search of J.S. Beards (Beard et al. 2013) vegetation classification places the survey area within three System and Vegetation Association (Source Pre-European dataset, DPIRD-006; Map 3 in Appendix A).

- System Association Name: Pinjarra.
- Vegetation Association Number: 1182.
- Structure Description: Woodland southwest.
- Floristic Description: Jarrah, marri and wandoo Eucalyptus marginata, Corymbia calophylla, E. wandoo.
- Remnant Vegetation by Beard Association Rarity in LGA: 8.19% remaining (GoWA, 2019).
- Remnant Vegetation by Beard Association Rarity in IBRA Region: 11.38% (GoWA, 2019).

- System Association Name: Pinjarra.
- Vegetation Association Number: 968.
- Structure Description: Woodland southwest.
- Floristic Description: Jarrah, marri and wandoo Eucalyptus marginata, Corymbia calophylla, E. wandoo.

- Remnant Vegetation by Beard Association Rarity in LGA: 5.37% remaining (GoWA, 2019).
- Remnant Vegetation by Beard Association Rarity in IBRA Region: 6.62% remaining (GoWA, 2019).

- System Association Name: Bassendean.
- Vegetation Association Number: 1000.
- Structure Description: Woodland / Low woodland / Low Forest or Woodland.
- Floristic Description: N/A
- Remnant Vegetation by Beard Association Rarity in LGA: 40.8% remaining (GoWA, 2019).
- Remnant Vegetation by Beard Association Rarity in IBRA Region: 26.41% remaining (GoWA, 2019).

Mapping of the vegetation complexes by Heddle et al (1980) shows that three vegetation complexes occur across the Subject Site (Map 3 in Appendix A). These are described below.

- Vegetation Complex Name: Southern River Complex.
- System 6 Code: 42.
- Description: Open woodland of Corymbia calophylla (Marri) - Eucalyptus marginata (Jarrah) - Banksia species with fringing woodland of Eucalyptus rudis (Flooded Gum) - Melaleuca rhaphiophylla (Swamp Paperbark) along creek beds.

- Vegetation Complex Name: Swan Complex.
- System 6 Code: 33.
- Description: Fringing woodland of Eucalyptus rudis (Flooded Gum) - Melaleuca rhaphiophylla (Swamp Paperbark) with localised occurrence of low open forest of Casuarina obesa (Swamp Sheoak) and Melaleuca cuticularis (Saltwater Paperbark).

- Vegetation Complex Name: Guildford Complex.
- System 6 Code: 32.
- Description: A mixture of open forest to tall open forest of Corymbia calophylla (Marri) - Eucalyptus wandoo (Wandoo) - Eucalyptus marginata (Jarrah) and woodland of Eucalyptus wandoo (Wandoo) (with rare occurrences of Eucalyptus lane-poolei (Salmon White Gum)). Minor components include Eucalyptus rudis (Flooded Gum) - Melaleuca rhaphiophylla (Swamp Paperbark).

3.8. Conservation Significant Flora

Desktop inventory of potential Threatened and Priority flora species likely to occur within 20km of the property was undertaken using the following databases:

- 5km NatureMap Database Search (combined data from DBCA, WA Museum and WA Herbarium);
- 20km DBCA database search request for threatened flora (DBCA 2018);
- 5km Protected matters search tool (DAWE 2020); and
- WA Herbarium records accessed through Flora Base (Western Australian Herbarium, DBCA).

The conservation significance of flora species has been assessed using data from the following sources:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Administered by the Australian Government Department of Agriculture, Water and Environment (DAWE);
- Biodiversity Conservation Act 2016 (BC Act). Administered by the Western Australian Department of Biodiversity Conservation and Attractions (DBCA); and
- DBCA Priority Flora list. A non-legislative list maintained by DBCA for management purposes.

Database searches indicate that 69 conservation significant flora species occur within 20km of the Subject Site, please refer to Table A1 in Appendix B for full species list and Table A4 in Appendix C for likelihood of occurrence assessment. This list is comprised of 20 Threatened, 6 Priority 1 (P1), 9 Priority 2 (P2), 20 Priority 3 (P3), and 14 Priority 4 (P4) species. Of these 69 species only 6 had a flowering period consistent with the survey timing. Previous surveys conducted within the Subject Site found that one P4 species Eucalyptus rudis subsp. cratyantha is present (360 Environmental, 2016).

3.9. Threatened and Priority Ecological Communities

Desktop inventory of potential Threatened and Priority Ecological Communities likely to occur within 10km of the property was undertaken using the following database:

- 10km DBCA database search request for Threatened Ecological Communities (DBCA, 2019b).

Database searches indicate that 9 Threatened and Priority Ecological Communities may occur within 10km of the Subject Site. The 9 communities potentially present are:

- Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region (P3 / EN);
- Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands, Swan Coastal Plain (floristic community type 3c as originally described in in Gibson et al. (1994)) (CR / EN);
- Dense shrublands on clay flats (floristic community type 9 as originally described in Gibson et al. (1994)) (CR / EN);
- Herb rich shrublands in clay pans (floristic community type 8 as originally described in Gibson et al. (1994)) (VU / EN);
- Low lying Banksia attenuata woodlands or shrublands (P3 / EN);
- Quindalup Eucalyptus gomphocephala and/or Agonis flexuosa woodlands (P3);
- Southern Eucalyptus gomphocephala-Agonis flexuosa woodlands (P3);
- Subtropical and Temperate Coastal Saltmarsh (P3 / VU); and
- Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain (P3 / CR).

Please refer Table A5 in Appendix C for likelihood of occurrence assessment.

Database searches indicate that the Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region, may occur along the north western boundary of the Survey Area.

3.10. Conservation Significant Fauna

Desktop inventory of potential Threatened fauna species likely to occur within 5km of the property was undertaken using the following databases:

- 5km DBCA database search requests for threatened fauna (DBCA, 2019a); and
- 5km Protected matters search tool (DAWE 2020).

The conservation significance fauna species has been assessed using data from the following sources:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Administered by the Australian Government Department of Agriculture, Water and Environment (DAWE); and
- Biodiversity Conservation Act 2016 (BC Act). Administered by the Western Australian Department of Biodiversity Conservation and Attractions (DBCA).

Database searches indicate that 60 conservation significant fauna species occur within 5km of the Subject Site. This list is comprised of 49 bird, 1 Bivalvia, 1 fish, 1 invertebrate, 7 mammal and 1 Petromyzontida (lamprey) species. Please refer to Table A2 in Appendix B for full species list and Table A6 in Appendix C for likelihood of occurrence assessment.

3.11. Aboriginal and Cultural Heritage

Database records show the Collie River Waugul (ID16713) occurs within the south of the Survey Area which is listed as a mythological, natural feature, water source site (DPLH-001 dataset).

No other cultural heritage sites were identified during the desktop assessment.

4. Site Assessment

4.1. Vegetation Survey

4.1.1. Vegetation Survey Methodology

Bio Diverse Solutions (Bianca Theyer – Conservation and Wildlife Biologist / Ecologist) undertook the survey on the 25th and 26th June 2020 which is noted to be out of season for the South-West botanical province (EPA 2016a). The timing of the field assessment is not considered appropriate for a botanical survey in the Swan Coastal Plain bioregion. The purpose of the vegetation survey was to confirm desktop findings, provide context and gather knowledge in terms of broad floristic and vegetation descriptions of the wetlands and floodplain to help guide the Wetland Management Plan. The survey also aimed to identify any areas that may provide habitat for conservation significant flora and vegetation that may be considered as a TEC / PEC. The portion of Survey Area fronting the Subject Site is not proposed to be cleared or developed but to be managed under this Wetland Management Plan. Detailed or follow-up reconnaissance surveys may be required at a later stage. The Survey Area was surveyed via meandering traverses on foot, to identify the different vegetation types, their condition category and targeted survey for suitable habitat of conservation significant species. The vegetation types occurring within the Survey Area were mapped and described using opportunistic mapping and relevés. Relevés were systematically surveyed within representative vegetation types to enable categorisation across the Survey Area. Information collected within each relevé included:

- Location: coordinates of the relevé using a handheld GPS unit.
- Date and site code.
- Site description: landform, slope, soil colour and type.
- Vegetation description: dominant and non-dominant species present within the different growth forms and percentage cover.
- Vegetation condition.

4.1.2. Survey Limitations and Constraints

An assessment of potential survey limitations was undertaken as per the EPA (2016a) document Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment, refer to Table 4 below.

Table 5: Assessment of potential survey limitations.

Limitation	Comment
Experience of personnel	Bianca Theyer has 4.5 years' experience in flora and vegetation assessment working alongside Dr Ellen Hickman (Botanist) since working with Bio Diverse Solutions.
Availability of local / regional contextual information	Flora records and regional vegetation mapping information were available providing an appropriate level of background information prior to the survey. In addition, survey findings from previous years (Cardno BSD and 360 Environmental) were available.
Proportion of flora recorded and/or collected, and identification issues	360 Environmental recorded the P4 species Eucalyptus rudis subsp. cratyantha throughout the site. Areas previously assessed by 360 Environmental were generally not covered in this survey (different Survey Areas). Identification materials (fruits / nuts / flowers) of this species were difficult to find during this survey due to the height and lack of material. This species may be present in higher numbers than identified within this survey. 35 species were identified during this survey, the majority of these are introduced. One aquatic weed was unable to be identified.
Survey effort / extent and access	The Survey Area is large in size, as such only remnant vegetation and wetland areas were targeted (paddocks and grazing areas were excluded). No access restrictions were present.
Disturbances (e.g., fire or flood)	No recent disturbances were observed to have impacted the vegetation. The only disturbances to the Survey Area are through cattle being able to access the majority of the Survey Area. The historical disturbances of the site are not deemed to have affected the completeness of the survey.
Survey timing	The single season vegetation and flora survey was undertaken in June 2020 which is outside of the recommended survey timing for the bioregion. Spring is considered the optimal time for undertake vegetation and flora surveys within the region.

4.1.3. Vegetation Survey Results

During the field reconnaissance survey 35 flora species, consisting of 17 families and 27 genera were found. The most common families were Myrtaceae, Poaceae and Asteraceae. This list includes 10 native species and 25 introduced species (refer to Table A2, Appendix B). The Priority species Eucalyptus rudis subsp. cratyantha (P4) was identified within the Survey Area (see Section 4.1.4). No Threatened or additional Priority species were observed during the survey period.

4.1.4. Vegetation Types

Five vegetation types were described from within the Survey Area as described below. Refer to Map 4 in Appendix A for mapping, and Appendix B for full species list and relevé data. The five vegetation types found in the Survey Area include:

Corymbia calophylla woodland

This vegetation type is approximately 0.84ha in size and is located along the eastern boundary of the Survey Area within the Collie River Floodplain (UFI 1736). It is described as Corymbia calophylla woodland over *Cenchrus clandestinus, *Lolium perenne, *Bromus diandrus, *Briza maxima and *B. minor grassland. There are Melaleuca rhaphiophylla trees that line the small seasonal creek line area. The vegetation lacks any native mid or understorey species. This area of vegetation is surrounded by grazed pasture vegetation / paddocks and connects into adjacent wetland / floodplain vegetation. There are several well-worn cattle tracks through the area. Refer to Figure 2 below for photographs of the Corymbia calophylla woodland vegetation type.

Figure 2: Photographs of the Corymbia calophylla woodland vegetation type, including the Melaleuca rhaphiophylla lined creek-line.

Eucalyptus rudis & Corymbia calophylla woodland

This is the most commonly occurring vegetation type within the Survey Area and has a total area of 9.48ha. This vegetation type is almost solely restricted to the fringing vegetation along the Collie River (UFI 1736) except for a small patch in the south east portion of the Survey Area. Although fenced along the vegetation edge (except in a handful of locations) the vegetation has been altered through historical clearing and cattle grazing activities.

This vegetation type is described as Eucalyptus rudis and Corymbia calophylla woodland, over mixed introduced grass and herb grassland. The overstorey consists of mixed Eucalypts with sections where Agonis flexuosa and Melaleuca rhaphiophylla are present (and occasionally more dominant). This vegetation type also contains the stands of mixed Eucalyptus rudis and occasional Eucalyptus gomphocephala that are located to the west of both UFI 1870 and UFI 1719 (refer to Figure 3 below). The vegetation is generally devoid of native mid and understorey species, with the understorey consisting of introduced herbs and grasses. Commonly identified introduced species recorded in this vegetation type are *Oxalis pes-caprae, *Phytolacca octandra, *Briza maxima, *Briza minor, *Bromus diandrus, *Cenchrus clandestinus, *Cynodon dactylon, *Holcus lanatus, *Lolium perenne and *Rumex pulcher.

Figure 3: Photographs of the Eucalyptus rudis & Corymbia calophylla woodland vegetation type.

Isolated Eucalyptus rudis trees over Juncus subsecundus grassland

This vegetation type is associated with UFI 1719 and the wetland waterbody within UFI 0736 and in total is approximately 5.59ha in size. The vegetation is almost entirely devoid of overstorey vegetation except for the occasional E. rudis. The riparian vegetation consists entirely of Juncus subsecundus, Juncus sp., and introduces herbs and grasses equating to approximately 70-100% understorey coverage of the vegetated area. Introduced species identified in this vegetation type include * Cenchrus clandestinus, *Rorippa nasturtium-aquaticum, *Cirsium vulgare and *Gomphocarpus fruticosus. Refer to Figure 4 below for photographs of this vegetation type.

Figure 4: Photographs of the Eucalyptus rudis trees over Juncus subsecundus grassland.

Melaleuca rhaphiophylla and mixed Eucalyptus rudis & Corymbia calophylla forest

This vegetation type is associated with UFI 1870 and is 6.49ha in size. The fringing vegetation of this vegetation type is dominated by a mixed overstorey of Melaleuca rhaphiophylla, Eucalyptus rudis and Corymbia calophylla. The more central part of the vegetation consists entirely of an overstorey of Melaleuca rhaphiophylla. As with the other vegetation types there is no midstorey structure, and the understorey consists almost entirely of introduced herbs and grasses. In the more central part of the wetland there are large areas of bare ground, and it is evident these areas become waterlogged / inundated (some waterlogged areas were observed during the survey). Introduced species such as *Rubus ulmifolius, * Solanum nigrum and *Phytolacca octandra are present within the outside edges of the vegetation type as well as scattered internally. Introduced ground cover Cotula sp. are also present through the internal areas of the wetland vegetation. The wetland is not fenced off allowing cattle access the vegetation. This was evident through multiple tracks observed internally. There was also a large proportion of dead / fallen over trees within the wetland. Refer to Figure 5 over the page for photographs of this vegetation type.

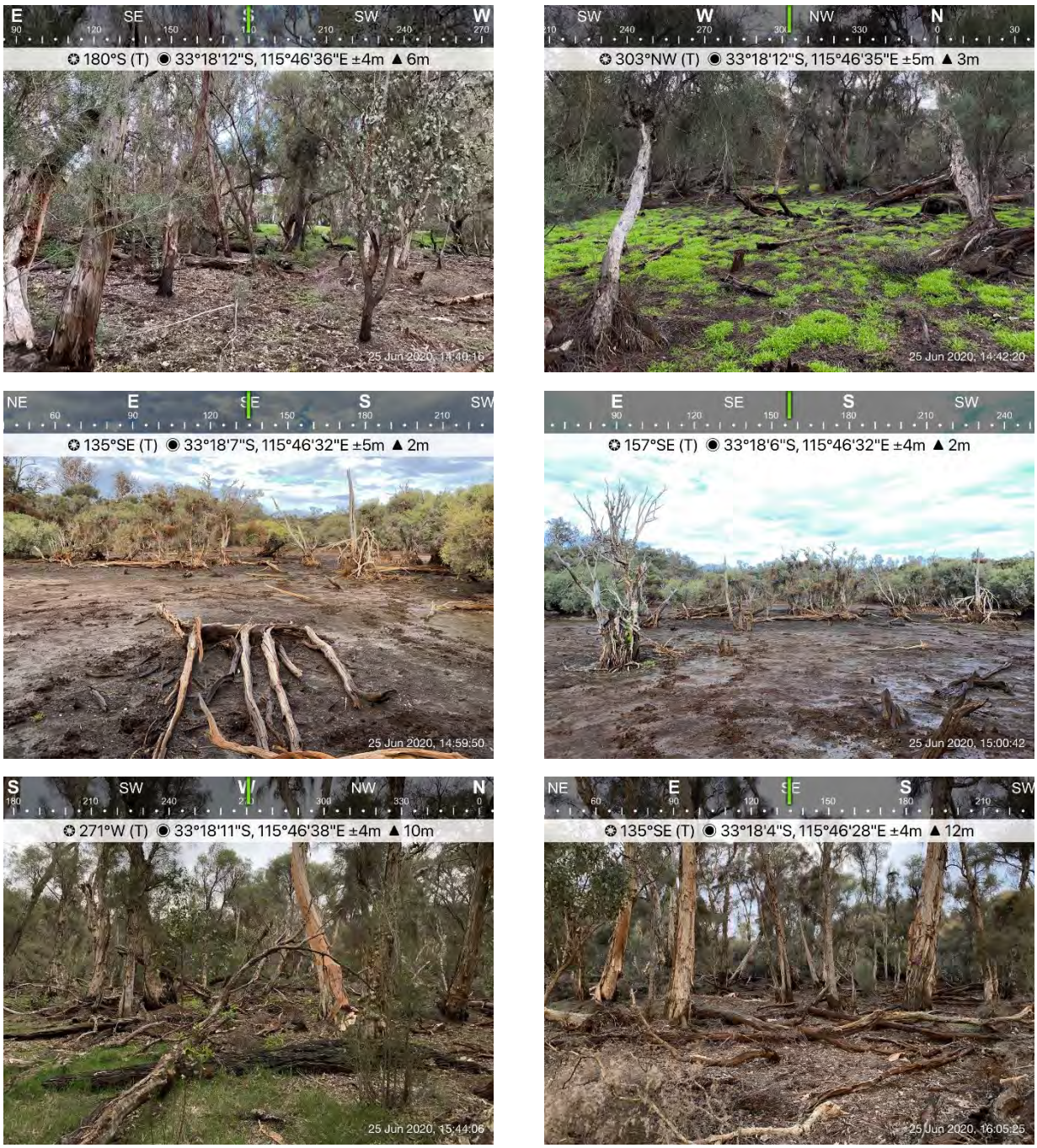


Figure 5: Photographs of the Melaleuca rhaphiophylla and mixed Eucalyptus rudis & Corymbia calophylla forest vegetation type, including the Melaleuca rhaphiophylla lined creek-line.

Juncus subsecundus, Juncus sp. and Cenchrus clandestinus grassland

This vegetation type is associated with UFI 15223 and is located to the east of UFI 1719. This vegetation consists solely of Juncus and Cenchrus clandestinus and is approximately 0.49ha in size. There is also an aquatic weed species that was present in the standing water and unable to be identified. The presence of this aquatic species indicates this area is permanently inundated. It is clear that the cattle utilise this as a source of drinking water due to the degraded banks. Refer to Figure 6 over the page for photographs of this vegetation type.

Figure 6: Photographs of the Juncus subsecundus, Juncus sp. and Cenchrus clandestinus grassland vegetation type.

Bare / cleared areas

The remainder of the Survey Area and the majority of the Subject Site consists of bare cleared areas utilised for cattle grazing. This vegetation type is associated with the multiple use UFI 15223, and within UFI 1736. This vegetation type is dominated by introduced pasture and weed species as well as scattered paddock trees. Given this area is predominantly outside of the Survey Area it was not intensely surveyed. Refer to Figure 7 below for photographs of the vegetation type.

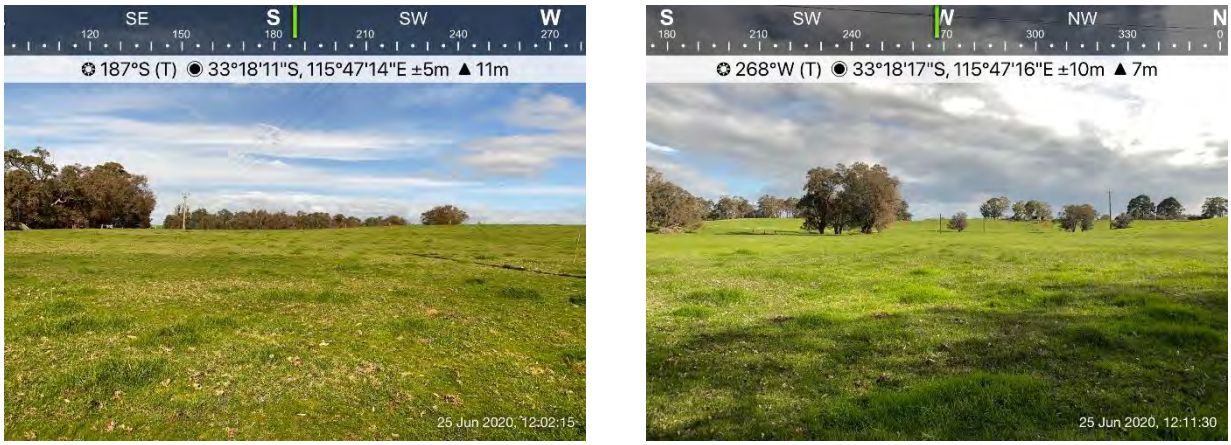


Figure 7: Photographs of the bare and cleared areas throughout the Survey Area and Subject Site.

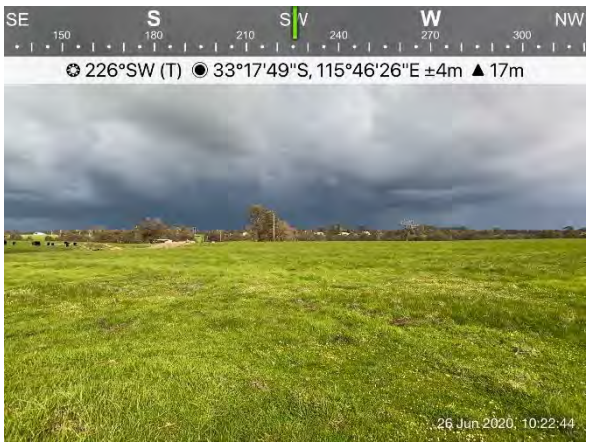


Figure 7 continued.

4.1.5. Vegetation Condition

The vegetation condition for the Survey Area as per the scale is outlined in Table A11 (Appendix D). Refer to Vegetation Condition Mapping in Map 4, Appendix A for the whole of the site and each wetland within the Survey Area.

There are varying degrees of degradation throughout the Survey Area caused by weed invasion, cattle access and historical clearing. Vegetation structure has been severely altered through the Survey Area and such has led to the vegetation being classified as both "Degraded" and "Completely Degraded".

The Completely Degraded areas are associated with the isolated Eucalyptus rudis trees over Juncus subsecundus grassland vegetation types as there is no vegetation structure retained. The dominant species is a mixture of Juncus and Cenchrus (Kikuyu) and there are obvious signs of multiple disturbances, with areas heavily accessed by cattle for grazing and drinking standing water.

The remaining areas of vegetation have been classified as "Degraded" again due to the obvious signs of multiple disturbances (cattle, clearing etc.) and the lack of vegetative structure. The mid storey structural layer is non-existent (excepting where juvenile trees may be present) and the understorey is dominated almost entirely by introduced weed species. The internal area of UFI 1870 may have historically had a reduced mid and understorey vegetative layer due to its seasonal waterlogged nature. However, there are obvious signs of cattle disturbance and the presence of invasive species such as Phytolacca octandra (red ink plant), Cotula sp. and occasional Solanum nigrum (blackberry nightshade) throughout resulting in a degraded classification. There were also high incidences of tree deaths throughout this wetland.

No areas of vegetation or wetlands themselves were classified as being in "Good Condition". Although the majority of the Collie River is fenced off, there are areas where cattle are still accessing the foreshore / bank areas. This is evident through tracks and eroded banks and hill slopes. This is particularly evident in the south west of the Survey Area with multiple entry points observed along the banks of the river. The steep slope adjacent to UFI 1870 also indicates that this section of the floodplain / river is heavily accessed by cattle. Refer to Figure 8 over the page.

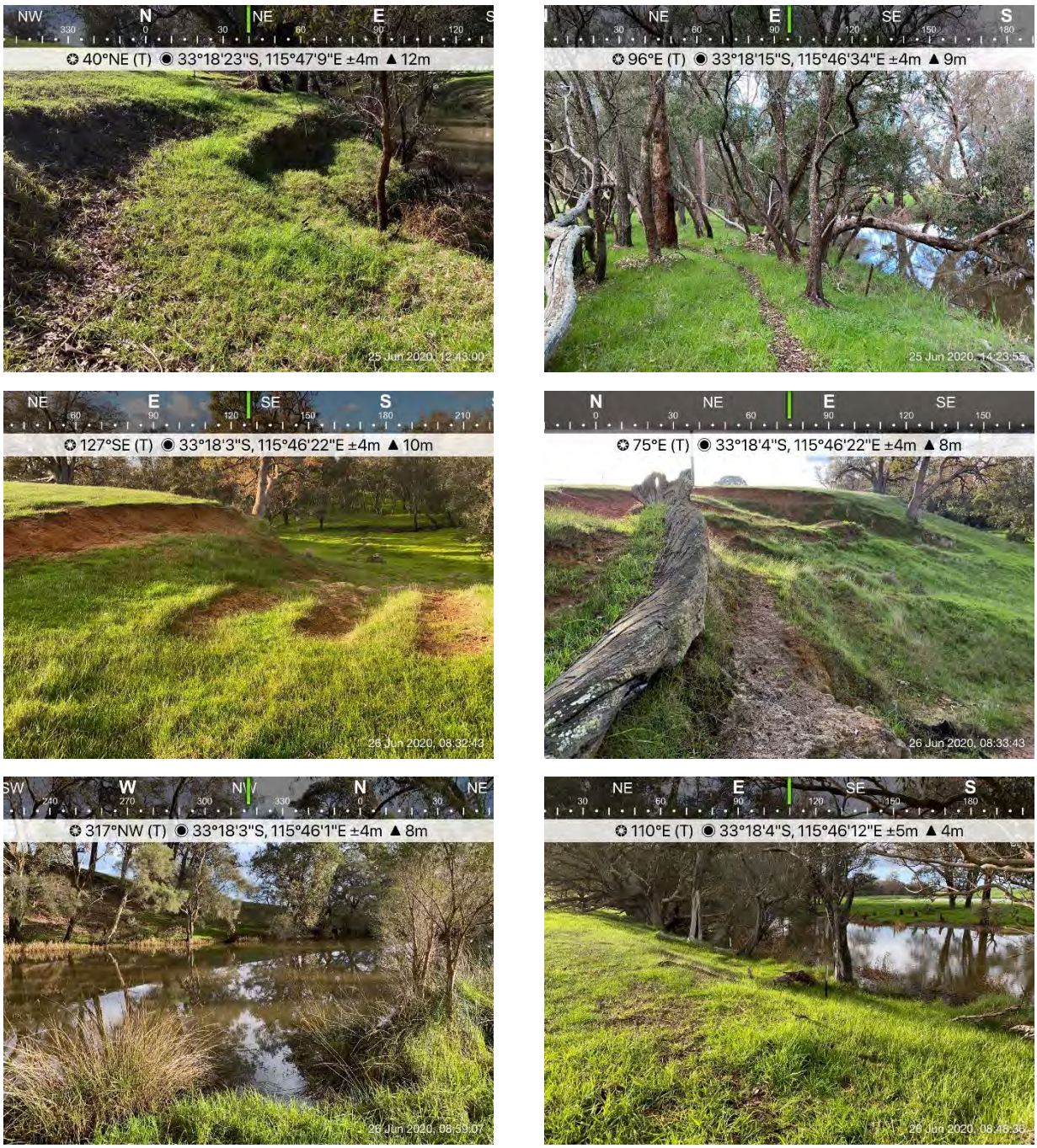


Figure 8: Photographs of river bank and hill slope erosion, as well as cattle and vehicle access points observed within the Survey Area.

4.1.6. Conservation Significant Flora

Of the 69 potential conservation significant species only one species the P4 Eucalyptus rudis subsp. cratyantha was identified within the Survey Area. This species has also been previously identified by 360 Environmental in 2016 to the north of the floodplain area. As these areas were outside of the scope for this survey, they were not reassessed in 2020. This species is distinguished by the larger size in buds / nuts and fruits to Eucalyptus rudis (Wheeler et al. 2002). Given the height of some individual trees and lack of identification material only those individuals with buds and nuts could be observed and marked as being the priority species. It is likely the priority species is in higher numbers throughout the Survey Area than what has been indicated during this survey period.

For species that were not flowering and that require flowers for accurate identification, a risk assessment was undertaken of habitat suitability (Table A4, Appendix C). Species were deemed either likely or unlikely to occur in the area based on habitat suitability (e.g., soil type, vegetation type, density etc).

4.2. Threatened and Priority Ecological Communities

No Priority or Threatened Ecological Communities were observed within the Survey Area. The Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region (P3 / EN) community that was mapped as being potentially present within the north west of the Survey Area was not deemed to be present. This area of vegetation has been previously cleared, with only paddock trees remaining. Please refer to Figure 9 below.

Although Eucalyptus gomphocephala (Tuart) was observed in some areas of vegetation it is not a dominant species and is unlikely to meet the approved conservation advice of the Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain ecological community. Furthermore, the patches are unlikely to meet size or condition requirements of the approved conservation advice.

Figure 9: Photographs of vegetation within potential mapped TEC area.

4.3. Introduced Flora (weeds)

A total of 25 introduced species were recorded within the Survey Area, which represented 71% of the total flora identified. The large representation of weeds indicates that the vegetation is in a degraded state with weeds starting to dominate the Survey Area.

Of the 25 species 19 are "Permitted – s11", and four are "Declared Pest - s22(2)" under the Biosecurity and Agriculture Management Act 2007. Under the Environmental Weeds Strategy for Western Australia (CALM 1999) four of the weeds are rated as "Low", two are rated as "Mild", 11 are rated as "Moderate", three are rated as "High" whilst two were not listed. The strategy classifies weeds according to their relative level of threat to conservation (high medium, mild or low) and this rating is based on their distribution, relative level of invasiveness and environmental impact. Weed mapping within the Survey Area is shown in Map 5 in Appendix A.

Table 6: Weed species recorded from the Survey Area.

Family	Species	Vernacular	WA Weed Strategy rating (CALM 1999) / BAM Act
Apiaceae	Foeniculum vulgare	Fennel	- / Permitted - s11
Apocynaceae	Gomphocarpus fruticosus	Narrowleaf Cottonbush	Moderate / Declared Pest - s22(2) (C3)
Asparagaceae	Asparagus asparagoides	Bridal Creeper	High / Declared Pest - s22(2) (Exempt)
Asteraceae	Cirsium vulgare	Slender Thistle	Moderate / Permitted - s11
Asteraceae	Conyza sp.		Low / Permitted - s11
Asteraceae	Cotula sp. (bipinnata ?)		Low / Permitted - s11
Asteraceae	Cotula sp. (coronopifolia ?)		Low / Permitted - s11
Brassicaceae	Rorippa nasturtium-aquaticum	Watercress	Moderate / Permitted - s11
Iridaceae	Watsonia sp.		High-Low / Permitted - s11
Moraceae	Ficus carica	Common Fig	Moderate / Permitted - s11
Oxalidaceae	Oxalis pes-caprae	Soursob	Mild / Permitted - s11
Phytolaccaceae	Phytolacca octandra	Red Ink Plant	Mild / Permitted - s11
Poaceae	Briza maxima	Blowfly Grass	Moderate / Permitted - s11
Poaceae	Briza minor	Shivery Grass	Moderate / Permitted - s11
Poaceae	Bromus diandrus	Great Brome	High / Permitted - s11
Poaceae	Cenchrus clandestinus	Kikuyu	Moderate / Permitted - s11
Poaceae	Cynodon dactylon	Couch	Moderate / Permitted - s11
Poaceae	Holcus lanatus	Yorkshire Fog	Moderate / Permitted - s11
Poaceae	Lolium perenne	Perennial Ryegrass	Low / Permitted - s11
Polygonaceae	Rumex pulcher	Fiddle Dock	- / Permitted - s11
Rosaceae	Rubus ulmifolius	Blackberry	Moderate / Declared Pest - s22(2) (C3 Exempt)
Solanaceae	Solanum linnaeanum	Apple of Sodom	Moderate / Declared Pest - s22(2) (Exempt)
Solanaceae	Solanum nigrum	Black Berry Nightshade	Moderate / Permitted - s11

4.4. Fauna

4.4.1. Fauna Survey Methodology

Field reconnaissance survey work was carried out by Bianca Theyer (Conservation and Wildlife Biologist / Ecologist) from Bio Diverse Solutions on the 25-26th June 2020 in accordance with Guidance Statement 56: Terrestrial Fauna Surveys (EPA 2016b) and Technical Guidance: Sampling methods for Terrestrial vertebrate fauna (EPA 2016c).

The survey was undertaken with a transect based approach, observational sampling techniques such as searching for tracks and scats, active searching and bird observation / calls were utilised during the survey period. Detailed assessments of trees were not undertaken as part of this survey (i.e., no measuring or assessment of significant trees or hollows). The aim of the fauna survey was

to provide information on faunal species assemblages present and to identify if conservation significant species or suitable habitat were present in the Survey Area.

A summary of fauna recorded during the survey is presented in Appendix B. Refer to the following sections for survey outcomes.

The assessment was carried out in a manner consistent with the following documents developed by the EPA and Department of Environment and Energy (DAWE formerly the Department of Sustainability, Water, Population, and Communities (DSEWPaC) and Department of the Environment, Water, Heritage and the Arts (DEWHA):

- EPA (2016b) Technical Guidance: Terrestrial Fauna Surveys;
- EPA (2016c) Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna;
- DEWHA (2010) Survey guidelines for Australia's Threatened birds; and
- DSEWPaC (2011) Survey Guidelines for Australia's Threatened Mammals.

No seasonal sampling was conducted during this fauna assessment. The results presented are based upon field data collected over a limited period of time and are indicative of the environmental condition of the site at the time. Some fauna species are reported as potentially occurring within the Survey Area based on the presence of suitable habitat (quality and extent) within the Survey Area or immediately adjacent. With respect to opportunistic observations, the possibility exists that certain species may not have been detected during field investigations due to seasonal inactivity during the field survey, species present within micro habitats not surveyed, cryptic species able to avoid detection and transient wide-ranging species not present during the survey period. Lack of observational data on some species should therefore not necessarily be taken as an indication that a species is absent from the site.

No survey limitations or constraints were encountered during this survey. See below for further details.

Table 7: Fauna survey limitations.

Limitation	Comment
Scope	The scope was to identify if any conservation significant species or suitable habitat were present in the Survey Area.
Disturbances that may affect results	No recent disturbances (fire etc.) were observed to have impacted the vegetation. Historical disturbances of the survey area are not deemed to have affected the completeness of the survey.
Intensity of survey	The Survey Area was adequately covered by field staff over the two-day survey period. No access restrictions were present.
Sources of information (recent or historic) and availability of contextual information	Desktop records and regional information were available providing an appropriate level of background information prior to the survey. Site specific data is limited as no detailed fauna surveys have been conducted within the area, this is not considered a limiting factor for this survey.
Remoteness or access issues	All resources required for this survey were available. No restrictions were encountered. All areas were accessible on foot.
Experience of personnel	Bianca Theyer has 4.5 years' experience in fauna assessment working alongside Dr Karlene Bain (Wildlife Ecologist) since working with Bio Diverse Solutions.

4.4.2. Fauna Survey - Results

Twenty-six fauna species were detected during the survey (refer to Appendix B). Of these 26 species; 22 birds, 3 mammals and 1 frog were identified within the Survey Area. The only conservation significant species detected during the survey period was Calyptorhynchus banksii naso (forest red-tailed black cockatoo (VU)). This species was detected through one location of freshly chewed nuts, but was not considered as a significant feed. No black cockatoos were seen flying or heard calling during the two-day survey period. The Survey Area contains a high proportion of mature trees, some of which are likely to meet the significant tree threshold of >500mm DBH. As stated, significant trees were not assessed as part of this survey, however, some trees hold some hollow bearing potential. No suitably sized breeding hollows were observed during the survey period. Feeding habitat for the three black cockatoo species is present along the fringing vegetation of the Collie River, and some scattered jarrah and marri trees in other vegetation types or in the cleared bare areas (paddocks). Given no significant feed events were observed during the survey it is likely this area is not a favoured feeding site for the three species.

Detailed assessments of trees were not undertaken as part of this survey however, there were multiple tree scratching and scats at the base of trees observed throughout the Survey Area consistent with Trichosurus vulpecula subsp. vulpecula (common brushtail possum). One small hollow (approx. 8cm x 15cm) with tracks up the trunk to the entrance was observed within one tree along the

fringing Collie River vegetation. No scats could be located at the base of the tree and the hollow couldn't be physically inspected. A hollow this size could provide habitat for a small arboreal mammal such as the CR Pseudocheirus occidentalis (western ringtail possum) and CD Phascogale tapoatafa wambenger (brush-tailed phascogale). The vegetation along the Collie River likely holds the most habitat value for these two species, however it is marginal. The habitat composition within the Survey Area contains favoured feed species (Peppermint, Marri and Jarrah) for Pseudocheirus occidentalis, but they are not present in significant numbers to provide substantial feeding areas.

UFI 1870 also contains habitat value for fauna species within the area as the vegetation is relatively intact. Although considered degraded due to the lack of strata, there is still a high proportion of overstorey species that provide habitat for birds and arboreal mammals. The relatively open nature of the wetland also provides habitat for kangaroos to be able to move into and rest in the area, with kangaroo scat observed throughout the wetland.

The other wetlands in the Survey Area hold habitat value particularly for amphibians and water birds. Frog species likely to occur in the Survey Area are typical of the Swan Coastal Plain and include species such as Heleioporus eyrei (moaning frog) and Geocrinia leai (ticking frog). Geocrinia leai was the only frog species heard calling during the survey period. The open nature of the sedges surrounding two of the wetlands hold very little habitat value for bird or mammal species.

No conservation significant water birds were observed within the survey period. The Collie River, seasonally inundated and waterlogged wetlands may provide marginal habitat to some conservation significant species such as Oxyura australis (blue-billed duck), Rostratula australis (Australian painted snipe) and Tringa glareola (wood sandpiper). Given the lack of vegetative structure preferred by the three species it is unlikely they are utilising the area.

The wetland areas and the Collie River provide suitable habitat for the P4 Hydromys chrysogaster (water rat), however no signs of burrows in banks and no signs of feeding were observed during the survey period.

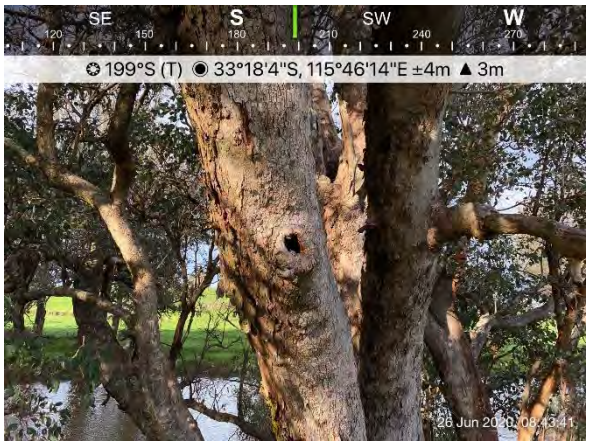
Overall, the Survey Area contained fair – good quality fauna habitat in areas where vegetation is present. Fauna habitat in bare cleared areas are classified as Completely Degraded. Refer to Table 7 below for habitat classifications.

Table 8: Habitat classification for vertebrate fauna

Fauna Habitat	Description
Very Good	Vegetation mostly native, all strata intact, a few old tracks that have grown over, a few non-invasive weeds present.
Good	A mix of native and introduced plants, all strata intact, a few tracks that are used occasionally.
Fair	Native vegetation >50% remaining, many weeds present, some bare areas, some used tracks.
Degraded	Less than 30% native vegetation remaining, numerous tracks, cleared areas, soil heaps, ground cover non-existent or > 90% weeds or introduced trees.
Completely Degraded	No vegetation remaining, virtually no habitat for fauna other than human made structures, weeds or introduced trees.

a)

b)



c)

d)

e)

f)

Figure 10: Photographs of faunal indicators and potential habitat.

Photographs a) & b): brushtail possum scat and tree scratchings; c) small hollow located in vegetation along the Collie River; d) chewed marri nuts; e) & f) photographs of the adjacent Collie River that may provide habitat for water birds and the water rat.

4.4.3. Conservation Significance

Conservation status of fauna species is assessed under State and Commonwealth legislation: in particular the Biodiversity Conservation Act 2016 and the Environment Protection and Biodiversity Conservation Act 1999 (C"wlth) (EPBC Act). Protected fauna that could possibly occur in the Survey Area was assessed by reviewing the field survey and desktop results and are presented in Table A6 in Appendix C.

As no vegetation is proposed to be cleared, there are minimal impacts identified to existing native fauna within the Survey Area.

4.5. Disease

4.5.1. Dieback

Phytophthora cinnamomi, otherwise known as Dieback, is a soil borne water mould which causes large scale death of vegetation. Over 40% of Western Australia's native plant species are susceptible to this disease and vegetation death caused by P. cinnamomi species represents one of the biggest threats to biodiversity in the state. A survey for the presence of P. cinnamomi was not conducted for the purposes of this report.

4.6. Existing Cultural and Social Value and Use

4.6.1. Community Use

Social functions pertaining to wetlands are related to recreation and appreciation/amenity. Recreation includes active recreation or passive types such as bird watching, walking and nature studies. The degraded nature of parts of the wetlands has resulted from previous land use activities, including cattle grazing that has created multiple pathways and trampling of vegetation throughout the wetlands. No public use is currently noted to occur as the area is private property. Informal access to the Collie River was noted along the Survey Area boundary.

4.7. Bushfire Risks

The identified bushfire risks associated with the Subject Site include the continuous vegetation running along the Collie River bank to the east and west of the site and the small patches of remnant vegetation throughout the site. These areas present as predominantly Woodland and Forest vegetation and are generally downslope in relation to the development area. These areas present as a High bushfire risk. Under hot, dry and unstable conditions (Severe to Catastrophic bushfire weather) the site is most at risk of a bushfire from these areas. The predominant site vegetation is Grassland which presents as a Moderate to Low bushfire risk.

The proposed revegetation areas to the south, southwest and southeast of the site are expected to at maturity present as Forest and / or Woodland, this presents a high bushfire risk but with appropriate setback the risk of bushfire from these areas is considered manageable. The proposed revegetation of the creek line in the southwest of the Subject Site is expected to at maturity present as shrubland, with a Moderate associated bushfire risk. This vegetation will be separated from the wetlands and Collie River vegetation by the BORR and the proposed development. More information regarding the bushfire risks associated with the site are presented in the Bushfire Management Plan (BDS, 2021).

5. Potential Impacts from Development

5.1. Soils

There is potential that construction works for the proposed development may lead to sedimentation in the wetlands and / or erosion of soils in the Subject Site, in the seasonal creek line and / or in the wetlands. Removing the topsoil for development works exposes the soil to movement during storm events and high winds. There is also potential for erosion of soils on the steep slopes between the floodplain and the Subject Site when / if exposed to increased runoff rates or an increased runoff velocity. Considerable fill will also be required throughout the development to meet groundwater separation requirements, there is potential for movement of the fill during storm events or high winds towards the wetlands/flood plain if management strategies are not in place.

5.2. ASS

The presence of potential ASS within the boundaries of the Collie River floodplain (UFI 1736) has been mapped as a High to Moderate risk. Given development exclusion is to apply across this area no disturbance of soils shall occur here. The remainder of the Subject Site has a Moderate to Low risk of ASS occurring at depths greater than 3m. Excavation on site is likely to be limited to road subbase, shallow services (power and water) and housing footing and is unlikely to be significant disturbance to potential ASS. Further investigation may be required prior to soil disturbance and management should follow the Department of Water and Environmental Regulation guidelines.

5.3. Hydrology

Potential hydrological impacts from the development include:

- Alteration to wetlands and/or river hydrological regime due to land use and stormwater flow path alterations;
- Deterioration in wetlands/river surface water quality through development activities; and
- Alteration and deterioration to groundwater regime and/or quality impacting the groundwater dependant wetlands.

5.4. Vegetation and Flora

Aspects and activities of the development that may potentially impact vegetation and flora in the area include:

- Introduction or spread of weeds through increased vehicular traffic; and
- Introduction of pathogens through infested vehicular traffic.

As no vegetation is proposed to be cleared, there are minimal impacts identified to existing native vegetation within the structure plan area.

5.5. Fauna

Activities associated with the development may have the following potential impacts:

- Vehicle and machinery movement and other construction activities resulting in fauna deaths in wetland areas; and
- An increase in the number of feral fauna and pest species.

As no vegetation is proposed to be cleared, there are minimal impacts identified to native fauna within the Subject Site and Survey Area.

5.6. Ecological Linkages

No clearing is proposed of the wetland areas, there is no threat to further disruption to ecological linkages as a result of this project.

5.7. Disease

Construction activities may result in the spread of dieback (if present) into wetland areas or affect the revegetation strategies.

5.8. Fire

The potential bushfire risk from development construction is minor, given the low fuel state associated with the development site. Other potential bushfire risks associated with the wetlands within the Survey Area include the connected forest vegetation along the Collie River foreshore to the east and west of the wetlands. Bushfire risks to the wetlands will not increase as part of development works.

5.9. Aboriginal Heritage

The potential for Aboriginal heritage sites to be disturbed through construction activities is unlikely. Contractors should be educated on the appropriate measures to be undertaken if any materials suspected of being of Aboriginal heritage significance are discovered during construction / groundwork activities.

5.10. Community Use and Appreciation

A lack of education provided to the surrounding residential community can result in the aesthetic values of the wetlands not being recognised, and is seen as a potential impact. Other potential impacts include illegal dumping of waste from surrounding areas and an increase in noise and dust emissions during construction.

As part of the design process for the site, the wetlands were identified as significant features to be protected. Public Open Space (POS) will be provided through a series of public access nodes to allow for passive recreational activities throughout the foreshore area. This will be done at subdivision stage along with the preparation of a Foreshore Management Plan (FMP). While the wetlands provide landscape amenity to surrounding residents, the buffer associated with wetland POS areas, will provide passive recreation opportunities (walking, cycling, running, nature watching) through the provision of paths and possible signage relating to the biodiversity of the wetlands.

6. Wetland Buffers and Development Exclusion Areas

The recommended wetland buffers and development exclusion areas are presented in Table 9 and shown in Map 7 (Appendix A). 50m buffers have been applied from the mapped (DBCA dataset) edges of UFI 1734, 1870, 1736 and 1719 and will become the future foreshore reserve. In the eastern portion of the site there is a development exclusion area applied to a portion of UFI 1736 on the low-lying flood plain that is within the development area (Map 7). A 50m development exclusion area shall also apply around the creek line in the southwest located within UFI 15223.

Table 9: Proposed Wetland Buffers.

UFI	Management Category	Buffers / setback from mapped wetland edges
1734	Conservation	50m
1870	Resource Enhancement	50m
1736	Multiple Use	50m to development footprint. 30m associated with wedge of vegetation along the eastern boundary.
1719	Multiple Use	50m
15223	Multiple Use	50m associated with wetland and creek / drainage line.

The wetland / creek line associated with UFI 15223 and the floodplain area within the east of the Subject Site associated with UFI 1736 can be retained within lots with development exclusion areas to apply. The remaining wetland areas and their respective buffers shall be excluded from the development area. 100m buffers between waterways/creek lines and onsite effluent disposal areas are also proposed, this includes 100m setbacks from the creek line in the southwest and 100m setback from the Collie River. Setbacks to effluent disposal areas are discussed in more detail in the Site Soil Evaluation (BDS, 2022) for the site.

7. Construction Management

Construction activities could affect the wetlands via:

- Surface runoff of sediments into wetlands;
- Trampling of existing vegetation in the wetlands;
- Introduction of further weeds into wetlands; and
- Alteration to wetland hydrology from development activities.

The following construction management strategies are proposed:

7.1. Soils and Earthworks

Disturbance of soils and removal of topsoil during construction shall be limited to the stage/s of development that are due for completion, avoiding exposure of bare / disturbed soils for extended periods of time and limiting the area of disturbed / bare soil at any one time. Temporary measures shall be put in place to avoid the movement of sediment towards the wetlands / flood plain during construction. These measures shall include but not be limited to sand bagging, temporary fencing, temporary stormwater storages with graduated outfalls. Construction works shall occur in a manner consistent with an approved Erosion and Sediment Management Plan, which shall be submitted to the Shire by the civil contractor prior to commencement of works.

Additionally, prior to excavation works commencing at each development stage, a technical specification and drawings will be prepared by a Civil Engineer and provided to the developer and the contractor for the works summarising the following information:

- The stage within which earthworks will take place;
- Detail of any works adjacent to the ESA areas;
- Spill containment and contingency procedures while working adjacent to wetland areas;
- Rehabilitation, landscaping works or revegetation works for the stage;
- Briefings to site personnel, construction managers etc.; and
- A responsibility matrix detailing the management responsibilities of the environmental consultant, the site contractors and the developer.

A copy of the technical specification and drawings will be provided to Parks and Wildlife for their records. At the completion of the earthworks program for each development stage, Parks and Wildlife will be sent an Initial Closure Report confirming the site works undertaken and any affects to the wetland areas observed. The report will include volumes of excavation, management strategies employed, post construction actions and monitoring requirements.

7.2. Wetlands

Hard edges to the wetland buffers will ultimately occur via footpaths and / or bollards. Temporary fencing is to occur during construction periods to ensure there is no accidental damage to the wetlands. Details are to be outlined in the engineering drawings prior to commencement of subdivisional works. Any trees adjacent to the wetlands and wetland buffers areas should be retained where possible and detailed in the engineering drawings prior to construction.

7.3. Hydrology

A Local Water Management Strategy (LWMS) has been prepared for the site by BDS (2022) and a Urban Water Management Plan (UWMP) is proposed subsequent to the approval of the LWMS. The key design principles and objectives of the LWMS relating to the protection of the wetlands during construction are:

- Staging - If the drainage areas are not defined in the current stage application a temporary storage/swale shall be created to prevent the runoff of sediment into the wetlands and / or river.
- Dewatering - Any dewatering undertaken will occur in a manner consistent with a dewatering licence. Dewatering shall not occur within the wetlands or the proposed wetland buffers.
- Acid Sulphate Soils - ASS testing and management will be conducted where it is required for approval of a dewatering licence.
- Construction will occur in a manner consistent with the approved Erosion and Sediment Management Plan submitted to the Shire by the civil contractor. This plan will be consistent with the Shire of Harvey's planning policies.

8. Surface Water and Groundwater Management

A LWMS (BDS, 2022) has be prepared for the site, the LWMS forms the basis for decision making with respect to surface water and groundwater management for the proposed development and its potential impact on the wetlands. The LWMS (BDS, 2022) has been prepared in line with the following guidelines:

- Guidelines for Subdivision Development Shire of Harvey.
- Stormwater Management Manual for Western Australia (Department of Water, 2007).
- Better Urban Water Management (WAPC 2008).

The LWMS (BDS, 2022) addresses the following hydrological concerns for the proposed development:

- water quality measures;
- surface water management;
- groundwater management;
- water efficiency measures;
- implementation and construction; and
- monitoring.

8.1. Surface Water Management

The pre-development surface water hydrological regime of the Subject Site shall be maintained post-development to ensure that the existing surface water regime of the wetlands is maintained. The pre and post development hydrological regime is presented in the LWMS, which documents drainage catchment boundaries, drainage direction, land use runoff coefficients and storm water storage details. The stormwater from the proposed development will be conveyed via roadside swales sized to convey up the 1% Annual Exceedance Probability (AEP). Roadside swales discharge to bio-retention/stormwater storages sized to also retain up to the peak 1% AEP storm event. Stormwater storages shall be located within the Subject Site outside of the proposed foreshore reserve area (wetland buffers), with outflow from the storages sized to convey pre-development flow rates from the incoming sub-catchment. Outfalls for the storages shall be graduated to reduce the velocity of the outflow to 0.5m/s to avoid erosion on the steep slopes between the development and the flood plain.

8.2. Groundwater Management

The groundwater levels and quality shall be maintained or improved in the post-development scenario. Groundwater management strategies for the protection of groundwater resources includes setting groundwater design levels with any subsoils proposed for the development set at or above the groundwater design level. The groundwater quality within the Subject Site and of that feeding into the wetlands is expected to improve with the proposed land use change and the expected reduction in fertiliser use. Infiltration of stormwater within lots, the use of bio-retention storages and promotion of local native drought resistant plants shall be implemented for the maintenance or improvement of groundwater quality. Groundwater Management is discussed in more detail in the LWMS (BDS, 2022).

8.3. Water Quality Measures

There shall be no direct runoff from the development into the wetlands/river or the wetland buffers. Water quality management within the Subject Site will be achieved using a treatment train of structural and non-structural controls including; lot attenuation (soakwells / raingardens / rainwater tanks) and at source infiltration for high frequency low intensity (minor) storm events and bio-retention storages with amended soils and planted to treat road runoff from minor storm events. Water quality measures for the proposed development has been outlined in greater detail in the LWMS (BDS (2022) and shall be outlined further in the subsequent proposed UWMP.

8.4. Monitoring

A surface water and groundwater monitoring program has been designed to allow a quantitative assessment of hydrological impacts of the proposed development and potential impacts on the wetlands. Pre-development surface water and groundwater monitoring shall be conducted prior to development and include one year of monitoring to provide comparison baseline data. Pre-development monitoring shall include the installation and water quality and level monitoring of a series of groundwater bores across the Subject

Site, with at least two bores located on the flood plain adjacent to the wetlands. Monitoring shall also include surface water samples from the wetlands. Post-development monitoring results will be compared to pre-development monitoring and summarised in a monitoring report presented to DWER and the Shire of Harvey. All sampling will be conducted according to Australian Standards and all water quality sample testing will be conducted by a NATA approved laboratory.

9. Wastewater Management

The Subject Site is situated in an area that does not have access to deep or reticulated sewerage. The health and environmental requirements for wastewater treatment and disposal for developments not serviced by deep sewerage systems are contained in the Government Sewerage Policy, (DPLH, 2019). The Government Sewerage Policy (DPLH, 2019) states minimum requirements apply for all on-site sewage disposal systems.

A Site Soil Evaluation (SSE) (BDS, 2022) has been prepared for the Subject Site. The SSE details the site soils under late winter conditions and assesses the suitability for on-site effluent disposal across the site in relation to the proposed subdivision.

In summary the SSE identifies the majority of the site as suitable for onsite effluent disposal (BDS, 2021). Given the shallow depth to clay and groundwater across much of the site imported fill with a PRI $\geq$5 and special design requirements and distribution techniques are necessary to ensure the rate of percolation of effluent through the soil is greater than the effluent generation rate.

Irrigation systems (surface or subsurface) in conjunction with a secondary treatment system with nutrient removal have been identified as the most suitable system for future lots. Land application areas and the use of irrigation systems is described in more detail in the SSE (BDS, 2021).

10. Rehabilitation and Revegetation

10.1. Rehabilitation and Revegetation Areas

Revegetation is proposed around UFI 1870 and within UFI 1736 to the south of the Subject Site and along the creek line in the southwest of the Subject Site to minimise erosion and promote nutrient uptake from stormwater runoff prior to discharge to the wetlands and the Collie River. The areas proposed to be revegetated is shown in Map 8 (Appendix A).

Additionally, there are several areas that have become eroded on the steep slopes adjacent to UFI 1870 due to cattle and vehicle access. Given this area is not proposed for native revegetation, some stabilisation techniques will be required, and promotion of regrowth of grass in these areas. Mulched material, brushing or geofabrics should be used to help stabilise the area. The erosion / cattle tracks present in the vegetation along the eastern boundary will also require some stabilisation to enable natural regeneration.

The rehabilitation areas will be clearly defined prior to each subdivision stage and guided by the rehabilitation plan shown in Map 8 (Appendix A). The following objectives will apply to all rehabilitation works:

- To re-instate vegetation to continue the future biodiversity of the area;
- Assist naturally rehabilitating areas to return to pre-disturbed state;
- To establish vegetation through revegetation and regeneration of denuded areas with local endemic species through use of preserved topsoil;
- To reduce weed invasions and competition of weeds with native species; and
- To assist with on the ground implementation of the revegetation.

Exposed soil during revegetation works can be subject to prevailing winds and water erosion. Mounding of the revegetation areas will assist with the runoff from rehabilitated areas and brushing will reduce the effects of wind erosion. The mounding and contouring of soil will also assist in trapping water for seedling germination and growth. Mounding should occur along contours or in flat areas perpendicular to surface flow direction. Where revegetation is to occur along steep slopes contouring and mounding should be perpendicular to surface flow direction.

10.2. Rehabilitation Methods

1. The method of revegetation is to use the existing topsoil within the geomorphic wetlands, with spraying / mechanical removal of weed species two months prior to planting seedlings.
2. If imported topsoil is required for seedling establishment, imported material should be tested for compliance to disease and weed free status.
3. Topsoil within the wetland areas can be improved by mulching within the wetland area, topsoils from adjacent paddock areas is not recommended to be imported into the wetland boundaries.
4. Contouring and mounding (200mm) of slopes parallel to the banks or slopes is to occur prior to planting of seedlings.
5. If seeding required, seed will be collected at appropriate seasons from adjacent vegetation and dispersed over constructed soils if required for further revegetation.
6. Any weeds likely to significantly impact on the rehabilitation will be sprayed with Roundup or similar herbicide, or grubbed out, depending on the species involved.
7. Rehabilitation will be carried out promptly after soil disturbance.

10.3. Seed Stock

Where practicable, plant species used in revegetation works will be of regional provenance, defined as propagated from plant in the immediate geographic area or from areas that closely match the physical environment and the plant community types of the area to be planted.

In acknowledgement that sourcing sufficient plant stock can be difficult, particularly wetland species, tubestock from species that are found in the wetland areas in this locality may be sourced from available nurseries that are accredited by the Nursery Industry Accreditation Scheme of Australia (NIASA) which will guarantee the quality of the supplied material.

Different plant species have differing tolerances to groundwater levels and as a result, may prefer inundated and lower slope environments over slightly drier areas. The preferred species for revegetation of the wetland areas and their associated buffers are listed in Table 10 and shown in Map 8, Appendix A.

The final species selection will be subject to availability of seed previously sourced from adjacent to the site and / or from NIASA accredited nurseries sourcing dieback free seedling stock.

10.4. Surface preparation

To ensure that native seed germination and seedling survival rates are maximised, weed removal through scalping and providing optimal soil condition for germination (scarification) and root development (ripping) will be undertaken. Contouring paralleled to any banks or slopes would be undertaken to depths of 200mm.

10.5. Species Selection and Plant Allocations

Where practicable plant species used in revegetation works will be of local provenance, defined as propagated from plant in the immediate geographic area or from areas that closely match the physical environment and the plant community types of the area to be planted. Seed collection over the site and in adjacent wetland areas will be undertaken 12-18 months prior to construction commencing.

In acknowledgement that sourcing sufficient plant stock can be difficult, particularly wetland species, tubestock from species that are found in the wetland areas in this locality may be sourced from available nurseries that are accredited by the Nursery Industry Accreditation Scheme of Australia (NIASA) which will guarantee the quality of the supplied material. Furthermore, due to the difficulties in propagating large quantities of species (some of which are more difficult than others) it is suggested there be a 2-year lead time to ensure supply can be met.

Different plant species have differing tolerances to groundwater levels and as a result, may prefer inundated and lower slope environments over slightly drier areas. The preferred species for revegetation of the wetland areas and their associated buffers are listed in Table 10. The final species selection will be subject to availability of seed previously sourced from the site and/or from NIASA accredited nurseries sourcing dieback free seedling stock.

The species have been allocated as per the vegetation type, refer to Table 10 which outlines the vegetation type, zone id, area and plant species.

Species allocation/densities have been based on the following matrix:

- Eucalyptus Woodlands (EW) – Overstorey species 30%, Midstorey species 35%, Understorey species 35%.

Densities

Trees	1 stem/10m^2
Shrubs	1 stem/5m^2
Sedges	6-9 stems/1m^2

Table 10: Proposed species list for revegetation.
Note: This is a recommended species list. This should be refined prior to revegetation works being undertaken and as part of the future Foreshore Management Plan.

Wetland ID	Sedges / rushes	Shrubs / Trees	
UFI 1734	Juncus holoschoenus Lepidosperma longitudinale Carex appressa	Banksia attenuata Eucalyptus rudis Corymbia calophylla Melaleuca rhaphiophylla Astartea affinis Acacia pulchella Hakea lissocarpha	Hypocalymma angustifolium Melaleuca teretifolia Melaleuca viminea
UFI 1719	Juncus holoschoenus Lepidosperma longitudinale Lepidosperma tetraquetrum Carex appressa	Eucalyptus rudis Melaleuca rhaphiophylla Acacia pulchella Astartea affinis Kunzea micrantha	Hypocalymma angustifolium Melaleuca teretifolia Melaleuca viminea
UFI 1870	Juncus holoschoenus Juncus subsecundus Lepidosperma longitudinale Lepidosperma tetraquetrum Patersonia occidentalis	Corymbia calophylla (infill) Eucalyptus rudis (infill) Melaleuca rhaphiophylla (infill) Acacia incurva Astartea affinis Hakea ceratophylla	Kunzea micrantha Melaleuca viminea Melaleuca lateritia
UFI 1736	Juncus holoschoenus Lepidosperma longitudinale Lepidosperma tetraquetrum Carex appressa	Melaleuca rhaphiophylla Eucalyptus rudis Melaleuca lateritia Melaleuca viminea Astartea affinis	Acacia pulchella Acacia incurva Hibbertia cuneiformis Kunzea micrantha
UFI 15223	Juncus holoschoenus Lepidosperma longitudinale Lepidosperma tetraquetrum Carex appressa Baumea juncea Patersonia occidentalis	Melaleuca rhaphiophylla Eucalyptus rudis	

10.6. Seedling Planting

Planting of seedlings will commence after the season's first major rains (typically June / July) when the soil is sufficiently wet to plant without the need for additional watering and to allow maximum root growth and plant establishment before summer. Seedlings will need to be watered as appropriate (at least once a month) over summer to ensure survival. Individual species will be planted irregularly to reflect the distribution found in natural areas.

Infill planting will be carried out in subsequent seasons (autumn, winter and spring) as required. The quantities required for infill planting will be calculated through monitoring between plant installation in subsequent winters and autumns with final numbers being based on percentage survival rates of initial plantings.

10.7. Completion Targets

At the end of installation, a report will be provided to the Shire of Harvey detailing the final numbers of seedlings planted in the revegetation zones, and any variations from the original revegetation plan.

The following completion targets are hoped to be achieved post initial planting:

- A 90% survival rate of the planted seedlings within the designated areas. Should this rate not be met, infill planting will be required to raise the surviving plant numbers above 90% of the initial planting density;
- In the specified revegetation zones the target is less than 20% weed cover, and for all declared and priority weed species to be 0%; and
- Stabilization of banks that have become eroded.

10.8. Monitoring

The revegetation areas will be monitored and maintained for four years following installation to ensure progress towards the completion targets are met.

Four visits will be conducted to track progress and to initiate remedial action if required:

- First spring - to determine if there are any immediate losses as a result of transplant shock, weed competition, predation or weather-related impacts.
- First autumn - to determine mortality and survival rates over the first summer period.
- Second spring – to assess the long-term success of the revegetation operation and determine the need for further remedial works.
- Second autumn – to assess the long-term success of the revegetation operation and determine the need for further remedial works.
- For the remaining monitoring period, a yearly spring site visit should be undertaken to assess revegetation success.

Timing of assessments may be adjusted to suit the weather conditions. The results of each monitoring assessment will be compared to determine growth and mortality rates, and provided a quantitative measure of progress.

10.9. Maintenance

Revegetation maintenance work will be carried out in response to monitoring to ensure completion targets are met for the duration of the works period. A schedule for revegetation, maintenance works and monitoring are shown in Table 12 – Long-term Management Considerations.

11. Weed Management Plan

Weed management is to be used in conjunction with dieback disease management. The following Weed Management Plan is to apply to all aspects of site operations. All operations shall conform to this Weed Management Plan, and monitoring to occur post construction for any infestations. Weed management will primarily be undertaken through avoiding introducing new weeds to the area.

11.1. Aims of Weed Management Plan

The aims of Weed Management at will be:

- Maintain a weed free environment;
- Ensure all vehicles are clean on entry prior to any soil or vegetation movement;
- Comply with Dieback / Disease Management Plan in Section 14;
- Site is to be secured to prevent trespassers illegally accessing, dumping rubbish and green waste;
- All weeds on site removed promptly on discovery;
- Remove weeds from least affected areas to the most affected areas (Bradley Method);
- Do not use weed affected soils for rehabilitation, but remove infected soils to waste disposal; and
- Regularly monitor the site for invasive species.

If weeds are discovered on site, they will be treated using the following methodology:

- Large woody weeds will be burned, poisoned or removed from site and disposed to approved green waste;
- Small weeds will be sprayed by a licensed contractor or landholder; and
- Initial follow up spraying will be undertaken at 6 months and 18 months and repeated as necessary.

11.2. Program for Weed Control

The following program for weed management will be implemented prior to construction, construction activities, and post construction monitoring activities. During construction there will be provisions in the contractor's agreement of works aligned to this Weed Management Plan.

Table 11 (over the page) is a guide for aggressive common species (adapted from Department of Primary Industries and Regional Development (DPIRD) recommended techniques) and should be used as a guide to treat any infestations promptly. Further information for any species and recommended treatment not listed in Table 11 should be gained from the DPIRD.

Table 11: Weed Management Program.

Species	Treatment
Grasses	
Bearded Oat Avena barbata	A grass selective herbicide is preferred in most situations. A mixture of 5mL Targa® or Fusilade®212 (or 2mL Verdict®520) plus 100mL spray oil in 10L water applied in winter before flowering will provide control with little effect on broad-leaved species.
Kikuyu Cenchrus clandestinus	Manual control difficult. 100mL glyphosate (450g/L) in 10L of water whilst actively growing (spring/autumn). Repeat every 8 weeks or when regrowth reaches 5cm tall. Mowing and cultivation ineffective.
Guildford Grass Romulea rosea	Spot spray metsulfuron methyl 0.2 g/15 L + Pulse® or 2.5-5 g/ha + Pulse®. Apply just on flowering at corm exhaustion.
Ryegrass Lolium rigidum	Prevent seed set. Spray with 5mL Select® or 10mL quizalofop (100g/L) or 4mL Verdict®250 or 30mL Fusilade®Forte plus 100mL spray oil in 10L water in winter when the grass has 2-8 leaves. In agricultural settings ryegrass may be resistant to grass-selective herbicides and will need to be treated with glyphosate.
Blowfly grass Briza maxima	Hand weed or spraying. 10mL glyphosate in 10L water late winter to spring before flowering.
Woody Weeds	
Common Fig Ficus carica	Hand remove seedlings. Stem inject with 50% glyphosate and foliar spray regrowth with 10% glyphosate. For stems less than 30 cm diameter apply 250 ml Access® in 15 L of diesel to basal 50 cm of trunk (basal bark).
Olive Olea europaea	Hand pull or dig out seedlings and small plants ensuring removal of all roots. For mature plants cut to base and paint 50% glyphosate or apply 250 ml Access® in 15 L of diesel to base 50 cm of trunk (basal bark). Monitor sites for seedling recruitment.
Apple of Sodom Solanum linnaeanum	Apply a mixture of 120L amitrole(250g/L) in 10L water and spray the bush until thoroughly wet. Seelings / young plants can be manually removed with gloves. Manually remove and burn isolated plants. Triclopyr (600g/L) Garlon 600® I Cut stump 1L/30L biodiesel or diesel Foliar spray with glyphosate or triclopyr during Autumn and Spring.
Herbs	
Bridal Creeper Asparagus asparagoides	Spray 0.2 g metsulfuron methyl + Pulse® in 15 L water (or 2.5 - 5g /ha + Pulse®). Best results achieved when flowering. Persistent removal of the tops for several years exhausts tuber. Concentrate on removing vertical growth as this is where most seed is set.
Blackberry Rubus ulmifolius	Three annual summer applications of 100mLGrazon plus 25mL of pulse in 10L of water, use 100mL Glyphosate in 10L of water in sensitive areas (i.e., creek lines).
Night shade Solanum nigrum	Prevent seed set for several years. Hand remove plants before flowering and/or spray 20mL Starane in 10L water during the plant is growing in summer.
Narrowleaf Cottonbush Gomphocarpus fruticosus	Mechanical removal effective if root system is removed. Seedlings controlled with 4L/ha glyphosate(450g/L) or Grazon® applied in spring to early summer when plant is actively growing. For mature plants spray foliage and a 1m buffer area until just wet with 100mL Grazon plus 25mL Pulse® in 10L water in spring to early summer.
Ink weed Phytolacca octandra	Uproot heavy infestations and cut remaining plants 5cm below ground. Spraying is effective, 100mL Tordon 75-D in 10L water.
Fiddle Dock Rumex pulcher	Remove isolated plants by cutting their roots at least 20cm below ground level. Small infestations 0.5g chlorsulfuron(600g/kg) plus 100mL Tordon®75-D in 10L of water.
Cotula sp.	Manually remove isolated plants. Apply a range of herbicides such as Lontrel® in winter before flowering.
Watsonia sp.	Thick infestations difficult to control manually. 100g 2,2-DPA (740g/kg) plus 25mL wetting agent in 10L water is the preferred herbicide. Apply from flower stem emergence to mid flowering for best control. For larger areas use 10kg/ha 2,2-DPA (740g/kg) plus 0.25% wetting agent.

Ref: Western Australian Herbarium (1998-) and Moore and Wheeler (2002).

Disclaimer

Note: The above herbicide treatments in Table 11 are direct quotes from Southern Weeds and their control (J. Moore and J. Wheeler, Department of Agriculture and Food WA.) and The Western Australia Herbarium (1998-) the control methods are based on using common cultural, biological and herbicidal control techniques. The reader should read the label of herbicides for further information, MSDS and registration status.

11.3. Management and Control of Weeds

Initial management will be undertaken by the developer as part of the ongoing management. The annual spraying and weed management shall continue for a period of three years post works commencing. Some weeds such as kikuyu will be difficult to completely eradicate from the site without implementing extreme management objectives which will be costly and impractical in terms of long-term management. It is recommended that modest management objectives in regards to weed control are implemented and that non-declared and non-invasive weeds can be managed in a way that is periodically beneficial to site works and overall completion objectives (e.g., some non-invasive species are currently providing soil stabilisation). The larger areas within the riparian zone not revegetated will remain as grassland. This has been done in part to keep future maintenance for landowners / shire to a modest level. These areas will need to be mowed and maintained throughout the management period.

As the new foreshore area will be managed by the new landowners / shire weed management needs to be able to be successfully implemented with modest management. The new landowner may be required to continue the weed management program to ensure continued natural regeneration occurs due to a reduction in further establishment of weeds. Refer to Appendix E – Revegetation Management Plan & Implementation Schedule for management actions and timeframes.

Briefing information to site personnel during revegetation/planting will include but not be limited to:

- Maintain a weed free working environment through clean vehicles on entry to the site;
- Ensure weeds are not moved into weed-free areas through regular inspections of vehicles;
- Show personnel physical samples of weeds present on site;
- Regular inspections of undercarriage of machines;
- Techniques of topsoil management to be modified if weeds are present via removing infected topsoil's or spraying prior to soil disturbance; and
- Hand/mechanical removal of weeds to green waste.

12. Fauna Management

The site has been surveyed for significant fauna under the Biodiversity and Conservation Act 2016 and the Environmental Protection and Biodiversity Act 1999. The methodology and results of the fauna survey were presented in Section 4.4 of this report.

The following management measures have been developed and will be incorporated into the Engineering Specification to reduce the likelihood of impacts to native fauna. These measures have been developed with the aim to retaining, building and maintaining the habitat values of the site:

- No clearing to occur within the wetland boundaries / floodplain areas;
- Any trees adjacent to wetlands and wetland buffers areas should be retained where possible and detailed in the engineering drawings prior to construction;
- Prior to commencement of subdivision works, all trees to be retained located within the road reserve and lots will be flagged. These will be clearly marked and coded with information relayed to all site personnel;
- Minimal extent of clearing vegetation, keeping to disturbed areas;
- Turnaround areas and passing lanes to be restricted to existing cleared areas; and
- In the event of native vegetation being cleared a DBCA "Post Clearing Report" may be required to be provided to Parks and Wildlife within 28 days of a clearing event.

The following management controls are to apply and will be implemented to minimise impacts on native fauna:

- Clearing will be undertaken primarily in already cleared areas to allow fauna to move away from the area of disturbance;
- If clearing of black cockatoo habitat trees is deemed necessary this should be conducted outside the annual breeding season (from October to May) to avoid potential impacts to these threatened species;
- Ensure bushfire control measures are in place during all operations (no vehicle movement on 'Very High and extreme' Fire Danger Index (FDI) days, fast attack unit on site etc);
- Native fauna encountered during clearing will be allowed to make their own way from the site. If this is not possible operations will cease until the Environmental Officer has assessed the impact on the fauna species; and
- Any injured fauna encountered by the Contractor is given to local animal carers or a local vet.

A pre-construction site inspection will be undertaken by the Environmental Officer to flag any habitat trees / trees to be retained. A site walk over will be undertaken to ensure any further environmental considerations are managed. Mapping will be produced for site personnel during construction periods. A buffer from the development areas is to be provided to protect the nearby retained remnant vegetation (wetland) areas and retained trees on site. A suitable temporary demarcation barrier be erected 10m from the crown drip zone of any retained trees and a minimum of 15m from wetland areas to protect the trees, root systems and wetland areas from accidental machinery damage during development works.

An environmental briefing will occur prior to construction activities commencing to inform the Project Manager, Site Supervisor and all machine / vehicle operators of any sensitive areas and flag tape / signage / demarcation requirements. If during site works, there is any evidence of Threatened Fauna present then the Environmental Officer should be notified and work cease until a site assessment has been undertaken.

Briefing information to site personnel will include but not be limited to:

- Trees to be retained identified through flagging and demarcation;
- Ensure all soil works are a minimum distance of 1m away from base of any habitat trees;
- Ensure that any Threatened or suspected to be Threatened Species encountered are reported to the Environmental Officer;
- Ensure all operations are undertaken with a minimal footprint and the clearing of native vegetation is restricted to defined and necessary areas; and
- Prior to commencement of site works existing and potential hollow-bearing trees must be identified and mapped, (with live or dead Corymbia calophylla, Eucalyptus marginata, Eucalyptus rudis trees with a diameter at breast height (DBH) >500mm and regardless of age) being considered as potential Black Cockatoo habitat and retained where possible.

13. Fire Management

There is little potential bushfire risk from subdivision construction. However, fire is always a potential risk in remnant and rehabilitated vegetation. Perimeter firebreaks will be required to be maintained to the standards stated in the Shire of Harvey Firebreak Order.

A detailed Bushfire Management Plan (BMP) has been complied to guide the structure plan process (BDS, 2010). The approved BMP will be the guiding report for fire management during and post construction of the proposed development.

The approved BMP should be consulted for further detail, during construction management the following protocols should be adhered to. The following fire control methods should be enforced at all times during summer periods.

13.1. Fire control methods during construction

- Fire break maintenance will occur annually from 30th November (prior to Fire Season) to the 26th of April (post Fire Season);
- Clear a firebreak of all flammable material, for a width of no less than three metres (3m), immediately inside the external boundaries of the property;
- Trees must be trimmed back to provide a vertical clearance of a minimum four metres (3.5m) to allow fire appliances to drive along the firebreak;
- Areas cleared for any prescribed burning or burning off require a twenty metre (20m) firebreak;
- Abide by shire-imposed vehicle movement and/or harvest ban due to dangerous fire weather conditions or if there are bush fires already burning during the Restricted and Prohibited Burning Times (i.e., High-Very High Fire Danger days);
- Maintain at all times minimum 30,000L of water in separate firefighting tank for firefighting purposes during all construction activities;
- A mobile firefighting appliance dedicated to firefighting operations is located on the property at all times during summer operations;
- Maintain compliance with the Shire of Harvey Firebreak Order; and
- Ensure revegetation is as per this WMP.

14. Dieback Management

Human-induced spread of P. cinnamomi is generally through the movement of soil which causes the translocation of soil sediments, be it a large scale (i.e., soil brought in for infill) or small scale (i.e., soil brought in unknowingly on machinery, shoes etc.) incidents.

Due to the degraded nature of the vegetation and absence of indicator species, it is suggested that basic hygiene precautions are taken, especially during the wetter months in the wetlands to prevent the accidental introduction of disease (s) into the Survey Area, i.e., clean mud and soil from any vehicles before entering wetland areas, remove mud and soil from boots before entering the wetland areas and temporary fencing to exclude machinery in the area.

General protocols that would apply to the development include:

- Top soil movement/export from the bare paddock areas into the wetland areas is not undertaken to prevent spread of weeds and diseases;
- Top soil export from the subdivision to other areas within the subdivision (i.e., cut and fill) can occur however not be exported off site to “Greenfield areas” without disease testing;
- All machines and vehicles to be cleaned prior to entering the site; and
- Check any raw materials (imported) to be used for road construction or maintenance prior to use, to ensure such materials are disease free.

The site is most likely deemed infested, however good hygiene is to apply, some general principles recommend include:

- Earth moving vehicles and equipment are to be cleaned prior to entering site;
- Access to the site will be controlled (fenced and gated and locked when unattended);
- Completed areas will be rehabilitated as soon as practicable;
- The rehabilitated surface will be free draining and not contain wet or waterlogged soils;
- Materials used in rehabilitation will be dieback free from on site, additional plants or seeds will have to be certified dieback free;
- Signage erected to indicate dieback free areas and wash-down/brush down procedures; and
- Road and transport vehicles are to be restricted to defined roads, loading and turn around areas.

15. Control of Environmental Incidents

An important aspect in the environmental program is management of non-conformance or incidents. An environmental incident is an event which could result in pollution to the local environment. The planning of site works and methodology aims to limit the risk and harm of subdivision operations/works impacting on-site or off-site.

If an incident or event occurs, it should be emphasised to all personnel working on site that all incidents are documented. Investigations should be conducted and action plans established in order to ensure the event does not happen again.

15.1. Corrective and Preventative Actions

An Environmental Investigation should include the following basic elements:

- Identify the cause of the incident;
- Identifying and implementing the necessary corrective action;
- Identifying the personnel responsible for carrying out corrective action;
- Implementing or modifying controls necessary to avoid repetition; and
- Recording changes in written procedures required.

This should occur immediately from an incident occurring. It is recommended if an environmental incident occurs an Environmental Consultant is appointed to address the issue immediately and give advice on remedial actions.

15.2. Spill Management Procedures

The following information is from the DEC Spill Management Brochure (DEC 2011). This shall be the methodology employed should a spill from fuel or chemical occur.

Dealing with minor spills

A small spill is considered to be a spill of 5 litres or less providing the product is not concentrated. For concentrated products of any quantity the spill must be treated as a large spill.

1. Assess safety. Make sure that people are kept clear, and that you have the right training and equipment to deal with the spill.

2. Stop the source. Providing it is safe to do so, stop the spill at its source. This may involve righting an overturned container or sealing holes or cracks in containers.

3. Contain and clean up the spill. The spill should be mopped up immediately.

4. Record the spill. Record when, what, how and where the spill occurred, clean up measures undertaken and the names of any witnesses. Also make note of what changes can be made when handling, transporting or storing chemicals to ensure a similar incident does not happen again.

Dealing with large spills

A large spill is considered to be anything over 5 litres or concentrated chemicals of any volume.

1. Assess safety. Make sure that people are kept clear, and that you have the right training and equipment to deal with the spill.

2. Consult the Material Safety Data Sheet (MSDS). The MSDS will have instructions on how to deal with specific chemical spills.

3. Put on protective clothing. If necessary, put on gloves and goggles, a mask and an apron.

4. Stop the source. Providing it is safe to do so, stop the spill at its source. This may involve righting an overturned container or sealing holes or cracks in containers.

5. Contain and control the flow. The spill should be prevented from filtrating into the ground or entering the stormwater system. The outer edge of the spill should be dammed with rags, blankets, sand, sands bags, mops and/or absorbent booms.

6. Clean up the spill. Promptly cover the spill using absorbent materials such as the correct absorbent granules for the product (Note that some strong acids will react with some types of granules and sawdust), sand and rags, being mindful not to splash the spill. Using a dustpan or spade, the absorbent granules or sand must then be scooped up and placed into a container. This waste material is not to be buried or thrown into the environment. The method of disposing this waste will depend on the amount and the type of chemical that was spilt. The Department of Environment Controlled Waste Section will advise on the appropriate disposal of hazardous

substances. There are several contractors that will dispose of contaminated substances and soils. All contact phone numbers can be found below

7. Notify the appropriate authority. If the spill does enter a stormwater drain or open ground, the Department of Environment and your local council must be notified. Please refer to the phone numbers listed below. If there is a hazard to health or property, call Fire and Rescue on 000 immediately.

8. Record the incident. Record what, how and where the spill occurred and the names of any witnesses. Also make note of what changes can be made when handling, transporting or storing chemicals to ensure a similar incident does not happen again.

Who to call in an emergency

All hours phone numbers

Life / property emergencies: Ambulance, Fire or Police	000
Pollution emergencies - Department of Water and Environment Regulation	1300 784 782
Poisons Information Centre	13 11 26
Water Corporation – Emergencies and water service difficulties	13 13 75

16. Community Use and Appreciation – Access

16.1. Concept Landscaping

No landscape works will occur in the wetland areas with the emphasis being on weed eradication, revegetation and conservation. Any landscape plantings will be predominantly endemic Swan Coastal Plain species in the development areas of POS, drainage basins and roadside swales (bio-infiltration systems).

Hardscape features that may be installed within the wetland areas include a pedestrian pathway system comprising of wooden boardwalk and unsealed paths, and interpretative signage. However, this is yet to be defined and any infrastructure will be subject to approval from DBCA.

16.2. Landscape Specifications

Landscape Specifications will be issued as part of the landscaping tender for the subdivision area prior to construction of each stage. The Specifications cover the supply and installation of soft landscape materials including but not limited to:

- Soil mixes;
- Plant material (turf and trees); and
- Mulches.

The following Australian Standards are prescribed for use in implementing the landscaping works:

- AS 4454-1997: Composts, soil conditions and mulch.
- AS 3743-1996: Potting mixes.
- AS 4454-2003: Standard mark pasteurised mulch.
- AS 4454-2004: Standard mark composed soil condition.
- AS 4419(int)-1996: Soils for landscaping use.

16.3. Access

The wetland system has the potential to be a valuable and unique opportunity for passive recreational pursuits. Such activities could include nature walks, bird watching and picnic areas. The main focus for passive recreation is centred in the existing cleared areas of the wetlands. Opportunities may be explored by the developer to provide parkland landscapes outside wetland areas for recreation and amenity.

Suitable barriers or bollards should be installed along the agreed wetland buffer boundaries, or along the edge of roads and/or pathways, and along POS boundaries, to protect the wetlands, associated buffer areas and POS from deliberate or accidental damage by vehicles. This will protect reserve, wetland and POS areas.

16.4. Pathways

The wetland buffer area will be accessible to pedestrians and cyclists via a pathway network along the edge of the buffer. Hard edges to wetland buffers will occur via footpaths or road edges. Footpaths and trails will take advantage of the natural amenity of the wetlands and provide linkage for pedestrians and cyclists. The paths will be located primarily on the existing tracks that are throughout the vegetated areas to protect the existing vegetation.

Landscaping is yet to be defined, including the path network, this will be detailed at Subdivision phases in consultation with the Shire of Harvey.

16.5. Fencing

The only fencing proposed for this development is to maintain and replace the existing fencing along the Collie River. Fencing of native vegetation in the Development Exclusions Zones may be necessary to restrict cattle from accessing the areas. Fencing of the wetland / foreshore area is not proposed as part of this development. Temporary barriers will be erected to protect wetland areas from accidental damage during development construction periods. Hard edges to wetland buffers will occur via footpaths or road edges.

Suitable barriers or bollards should be installed along the agreed wetland buffer boundaries, or along the edge of roads and/or pathways, and along POS boundaries, to protect the wetlands, associated buffer areas and POS from deliberate or accidental damage by vehicles. This will protect reserve, wetland and POS areas.

17. Community engagement

A copy of the approved WMP will be placed on the developer's website to inform the community of the importance of the wetlands and their buffers. A website link can be provided in future promotional material for the development.

17.1. Education

The wetland, wetland buffer and surrounding area offer an opportunity for public education and appreciation as well as improving the general amenity of the subdivision area.

Public awareness of the value of the wetland environment may be promoted to the residents and the general public using the path system (yet to be defined). Management issues affecting the wetland can to be promoted through signage and educational pamphlets.

Signage information may include:

- Directional signage will be located at entry points into the pathway system from adjoining properties and the residential area. They will identify the location of pathways, facilities such as POS areas and other points of interest.
- Interpretative signage will be used to inform residents and the general public of the importance of the wetland area in providing habitat for native fauna and flora species. There may be interpretative signs installed along the length of the pathways each identifying a particular plant, mammal, reptile or bird species that may be found within the wetland and providing information regarding its behaviour, habits and where it is likely to be observed. In particular, reference will be made in the signage to aboriginal heritage and significance of the area to the aboriginal community.
- Public safety information signage warning the public of areas where potential hazards are known to exist (e.g., during rabbit baiting or larviciding treatments being conducted).

Signage where appropriate, will be clearly visible but not designed to detract from the aesthetic appeal of the viewing areas. Directional and interpretative signs may consist of painted waist high posts with sturdy, metal plaques. Public safety signs will be clearly visible and may need to be taller and of more notable design. It is important that a uniform style be developed for the signage in the wetland buffer area and agreed upon with the Shire of Harvey prior to signage fabrication and installation.

18. Long Term Management

The developer is responsible for maintenance of the site during development and maintenance periods. During the construction period subsequent to the issue of final approval, the developer shall have no further responsibilities to subdivision on individual lots that pass from their ownership and the road reserve. The Shire of Harvey is listed as a Stakeholder for consultation, advice and future owners of the road reserve and public amenities. The developer gives a commitment to undertake the following through the endorsement of this plan. The Environmental objectives to be maintained and monitored post construction are outlined below, please refer to Table 12.

Table 12: Long-term Management Considerations.

Objective(s)	Management Aims	Management Action(s)	Stakeholders	Performance Indicator	Indicator Measurements	Monitoring frequency
1.Weed Management	Reduce the impact and spread of weeds.	Remove all weeds through actions including: Hand/mechanical removal; and Spot spraying of individual plants.	Shire of Harvey The Developer Project Managers	Weed populations identified on site.	The recurrence of weed populations is minimal; and New populations of weeds do not occur.	Implement weed monitoring 6, 12 and 18 monthly program.
2.Stormwater and Groundwater Management	Maintain / improve wetland water quality parameters; Ensure stormwater flows from the subdivision both during and after construction do not adversely impact the wetlands; Ensure pre-development flow rates and pathways are maintained post development; and Ensure all stormwater controls are maintained in correct working function.	Development of a Local Water Management Strategy to document the surface water management, groundwater management and water quality measures for the proposed development; Outflows from the development shall be consistent with the pre-development scenario; Bio-retention storages utilised for retaining and treating storm water runoff. Bio-retention storages shall be located outside of the wetlands and their buffers; Outfalls for the stormwater storages shall be graduated to reduce the velocity of the outflow to 0.5m/s to avoid erosion on the steep slopes between the development and the flood plain; and Groundwater design levels shall be set at the peak annual water table level, with any proposed subsoils set at or above the groundwater design level.	Shire of Harvey The Developer Project Managers	Groundwater and surface water quality and quantity is monitored and compared to pre-development data; and Hydrological function is maintained in structures, no obstruction or pooling of water as per construction design (visual inspection)	No ponding of water for long periods in development structures following rainfall or unusual vegetation deaths, sludge or scum forming in and around the structures; Water quality in the wetlands appears to be clean and clear; carrying only suspended natural vegetation from natural stream or drainage lines and not carrying any scum or foreign material; and Measured water quality shall be equal to or better than pre-development water quality.	6 monthly visual inspection of all stormwater structures and / or after heavy rainfall events; and Quarterly post development surface water and groundwater quality and level monitoring.
3.Rehabilitation of degraded areas from any construction activities	Rehabilitate areas degraded by construction activities such batters or drains or clearing of native vegetation areas.	Revegetate degraded areas with preserved topsoil; Remove invasive weed species to prevent any vegetation structure decline; Prevent erosion through established vegetation and / or erosion control methods; and Collect adjacent seed in spring or flowering periods and spread in following autumn / winter periods to 'bulk out' revegetation areas if required.	Shire of Harvey The Developer Project Managers	The area (m^2) of degraded vegetation (percent weed establishment); Poor native vegetation condition of degraded areas; and Erosion does not occur after heavy rains or high winds during dry periods.	The area (m^2) of degraded vegetation (weeds) has been reduced and continues to reduce in area; Native vegetation continues to grow without assistance; and Erosion is minimal during high rainfall months or during dry periods with high winds.	6 monthly monitoring of rehabilitation areas.
4.Fauna Management	Remnant vegetation and rehabilitated areas attracts native fauna; Mature trees are conserved to attract native fauna and to be maintained for habitat; Thick areas of remnant vegetation are conserved to provide shelter and habitat for native fauna; and There is no displaced fauna or unusual deaths.	Informal checks along the road reserve; Hydrological flows are maintained to pre-construction conditions; Machine/vehicle speeds a maintained as a low speed environment to ensure wildlife not affected; and Signage and gates in place to ensure no illegal entry.	Shire of Harvey The Developer Project Managers	Fauna diversity; Signs of habitat use by local species in road reserve; and Fauna stay within remnant areas.	During maintenance visits, wildlife noticed in remnant areas; and Rehabilitated areas are vigorous and show no signs of demise.	Informal checks.
5.Fire Management	Prevent Fire Hazards within the site prior to, during and post subdivision construction and to ensure the bushfire management measure documented in the associated bushfire management plan and the Shire of Harvey Firebreak Order are complied with.	Ensure access along the road reserve/access ways are unimpeded for emergency entry / egress; Ensure any maintenance activities with machines do not occur on High Fire danger Index (FDI) days. Informal checks along the road reserve; Ensure any bushfire management measure documented in the associated bushfire management plan and Shire of Harvey Firebreak Order are met; and Ensure revegetation works are completed as per this wetland management plan.	Shire of Harvey The Developer Project Managers	The site remains within a low to moderate bushfire risk area and fire occurrence is minimal or none.	Leaf litter including wood material and grasses poses minimal fire hazard; and Machine movement bans during high FDI; No fire coming from the site.	Yearly prior to summer period; and Regularly monitor for vehicle movement bans.
6.Hygiene Management	Prevent any further spread or introduction of pathogens to the area.	In event of damage to the road surface contingency procedures are adhered to; Ensure disease free soil stock is used in wetland rehabilitation areas; and Maintain hygiene procedures across the site.	The Developer Project Managers	No further spread of Phytophthora to the area and adjacent foreshore area as a result of the road; and No introduction of additional diseases.	The road is not the cause of disease spread.	Quarterly checks.
7.Revegetation of wetlands	Rehabilitated areas attract native fauna; Thick areas of remnant vegetation are conserved to provide shelter and habitat for native fauna; and Rehabilitated areas are stabilised and promoting ecosystem values of the wetlands.	Checks for weed invasions and pest species; Ensure all site works in subsequent stages do not affect or damage rehabilitation efforts; and Maintain hygiene procedures across the site.	The Developer Project Managers	Meet completion criteria for rehabilitation prior to hand over to SoH Fauna diversity in wetlands; and Signs of habitat use by local species in wetlands.	A 90% survival rate of the planted seedlings within the designated areas.	Quarterly checks on wetland rehabilitation areas.
8.Annual Report	Update and advise DPAW on the listed objectives above 1-8 (Weed management through to Wetland Revegetation).	Complete report as per Table 12 format and include any other supporting documents as required.	Shire of Harvey The Developer Parks and Wildlife (DBCA)	As listed above, items 1-8.	As listed above, items 1-8.	Within the first 12 months of construction (including staging). Thereafter reporting should be Annually.

Regular management and maintenance will be carried out via the proponent for a post construction period of 4 years or as agreed to by the SoH and the developer (consideration to staged construction). The long-term management of the wetlands will become the responsibility of the Shire of Harvey. The developer has given a commitment to their management responsibilities through the release of the WMP document.

19. Responsibilities

The developer will be responsible for the implementation of the recommendations in this management plan, except where identified, for a period of four years from completion of development (refer to Table 12) to the satisfaction of the Shire of Harvey. The vesting and long-term maintenance of the foreshore reserve will be the subject of ongoing discussions with the Shire, DoW and DPLH. This is in recognition of the adjoining development's foreshore area being reserved as Regional Open Space.

20. Implementation and Review

The implementation of management strategies detailed in this WMP will be an on-going process, which should be flexible in responding to changes in the natural environment, the recreational use of the environment and community values. Monitoring procedures will assist in the adaptive management of the wetlands, as well as informing the progress of management.

The program of monitoring the success of the strategies is essential for the purposes of reviewing and updating the WMP by the Shire of Harvey. This will ensure that the objectives of the WMP are achieved and that any changes or new developments in management techniques can be incorporated.

An implementation Schedule over a 4-year period is supplied in Appendix E, this will be refined at subdivision stages and will be flexible to enable any staged development of the project. Updates to the WMP will occur during the life of the project, specifically the Implementation Table Appendix E.

21. Performance Monitoring

The developer will implement monitoring procedures to assess the success of management strategies addressing rehabilitation works, weed control activities water quality and feral animals during the four-year management period. This will allow the identification of area requiring augmentation or remedial works to be identified early and appropriately planned. In addition, the monitoring will ensure that an adequate representation of species and plant diversity is achieved.

21.1. Rehabilitation Performance Criteria and Reporting

Prior to the Shire of Harvey assuming responsibility for the management of the wetland area, the developer will need to demonstrate that the completion criteria for the rehabilitation works have been achieved.

The following completion targets are hoped to be achieved post initial planting:

- A 90% survival rate of the planted seedlings within the designated areas. Should this rate not be met, infill planting will be required to raise the surviving plant numbers above 90% of the initial planting density;
- In the specified revegetation zones the target is less than 20% weed cover, and for all declared and priority weed species to be 0%; and
- Stabilization of banks that have become eroded.

An annual progress report detailing rehabilitation work undertaken will be submitted to the Shire of Harvey. The reporting periods will be January to December annually for a period of 4 years or as per the subdivision maintenance period. This will be defined when staged development is known.

22. References

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23. Appendices

Appendix A – Figures

Appendix B – Species Lists and Relevé Data

Appendix C – Conservation Significant Values Likelihood of Occurrence Analysis

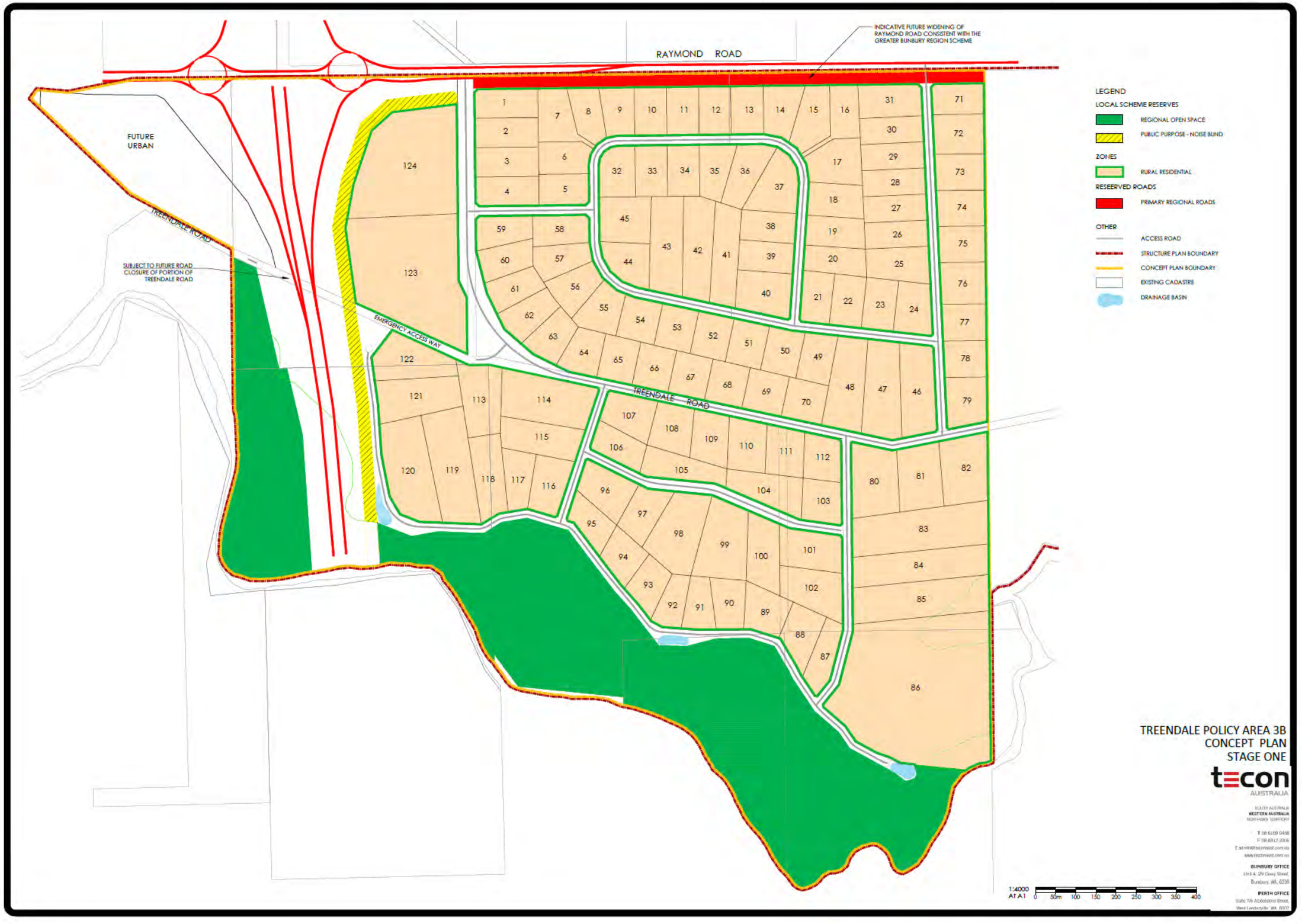
Appendix D – Conservation Status Definitions and Condition Scale

Appendix E - Revegetation Management Plan & Implementation Schedule

Appendix F – NatureMap and EPBC Act PMST reports

Appendix A

Maps


RAYMOND ROAD
INDICATIVE FUTURE WIDENING OF RAYMOND ROAD CONSISTENT WITH THE GREATER BUNBURY REGION SCHEME
FUTURE URBAN
TREENDALE ROAD
SUBJECT TO FUTURE ROAD CLOSURE OF PORTION OF TREENDALE ROAD
EMERGENCY ACCESS WAY
TREENDALE ROAD
LEGEND
LOCAL SCHEME RESERVES
REGIONAL OPEN SPACE
PUBLIC PURPOSE - NOISE BUND
ZONES
RURAL RESIDENTIAL
RESEERVED ROADS
PRIMARY REGIONAL ROADS
OTHER
ACCESS ROAD
STRUCTURE PLAN BOUNDARY
CONCEPT PLAN BOUNDARY
EXISTING CADASTRE
DRAINAGE BASIN
TREENDALE POLICY AREA 3B
CONCEPT PLAN
STAGE ONE
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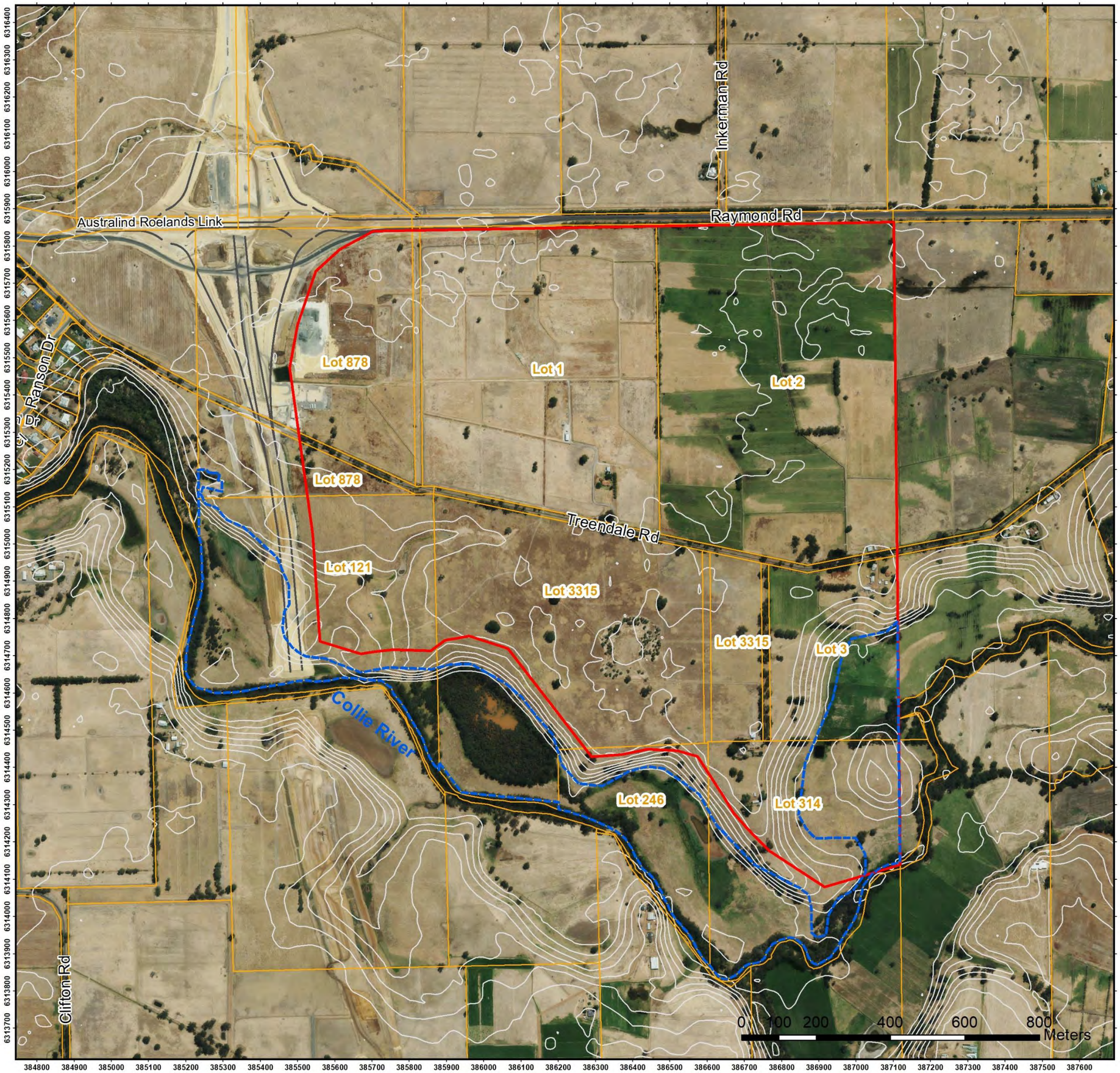
AUSTRALIA
1:4000
At A1



Overview Map Scale 1:250,000

Legend

- Survey Area
- Subject Site
- Cadastre
- Bunbury Outer Ring Road (future road)

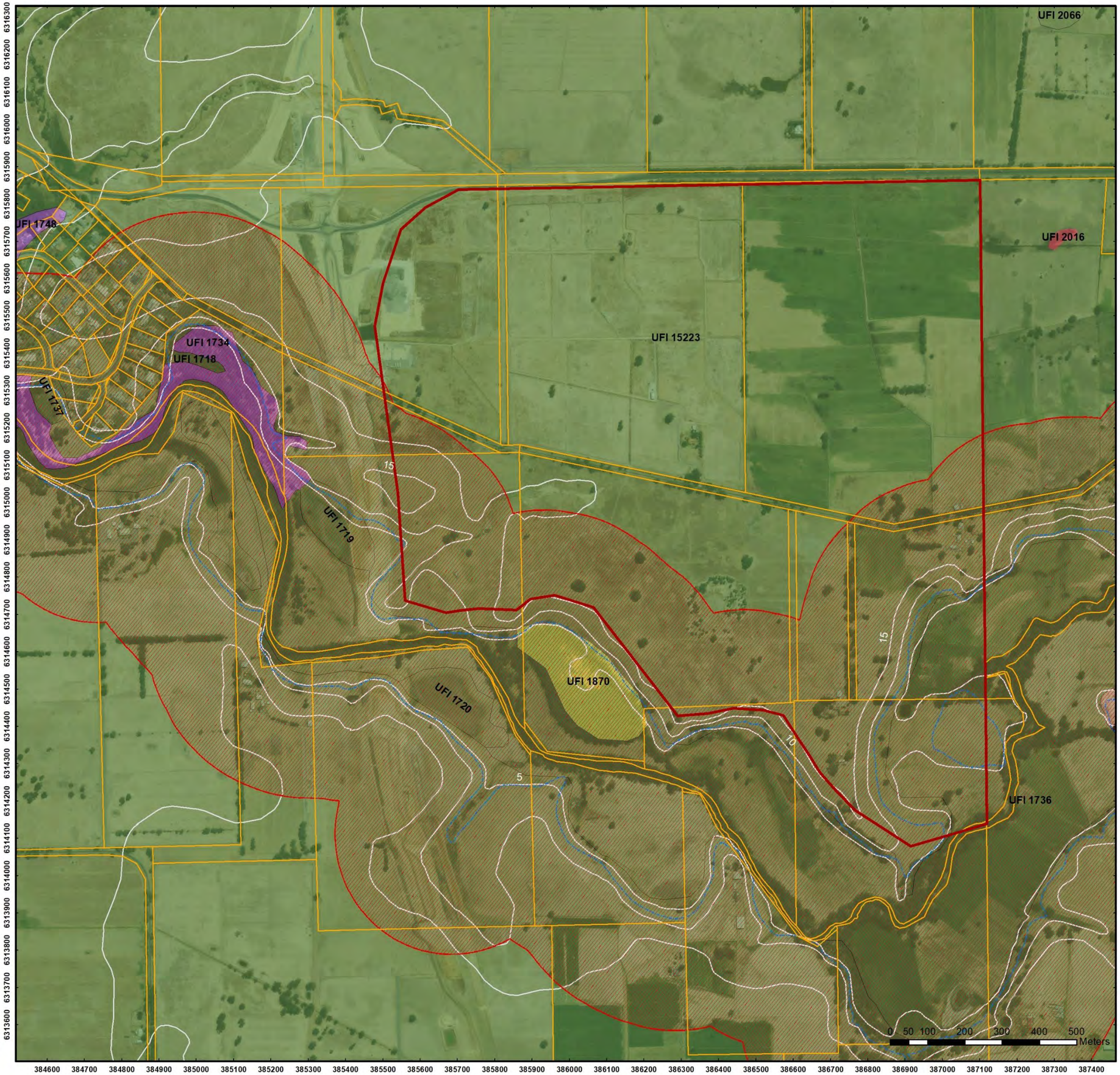
Scale
1:10,000 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

CLIENT
Tecon Australia
Treendale Structure Plan, Treendale Road
Roelands, WA 6226

Map 1: Location Plan

BAL Assessor	*QA Check*	*Drawn by*
JB	**KK**	**SA**
STATUS	*FILE*	*DATE*
FINAL	**MSC0285-001**	**04/08/2022**



Overview Map Scale 1:250,000

29 Hercules Crescent
Albany, WA 6330
Australia
Tel: 08 9842 1575
Fax: 08 9842 1575

Legend

- Subject Site
- Cadastre
- 5m Contours

Geomorphic Wetlands Swan Coastal Plain (DBCA-019)

- Conservation
- Multiple Use
- Not Applicable
- Not Assessed
- Resource Enhancement
- Extent of 1 in 100 (1%) AEP flooding (DWER-017)
- FPM 1 in 100 (1%) AEP Floodplain Development Control Area (DWER-003)

Scale
1:10,000@ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2016
Cadastre and Contours: Landgate 2016
Overview Map: World Topographic map service, ESRI 2012

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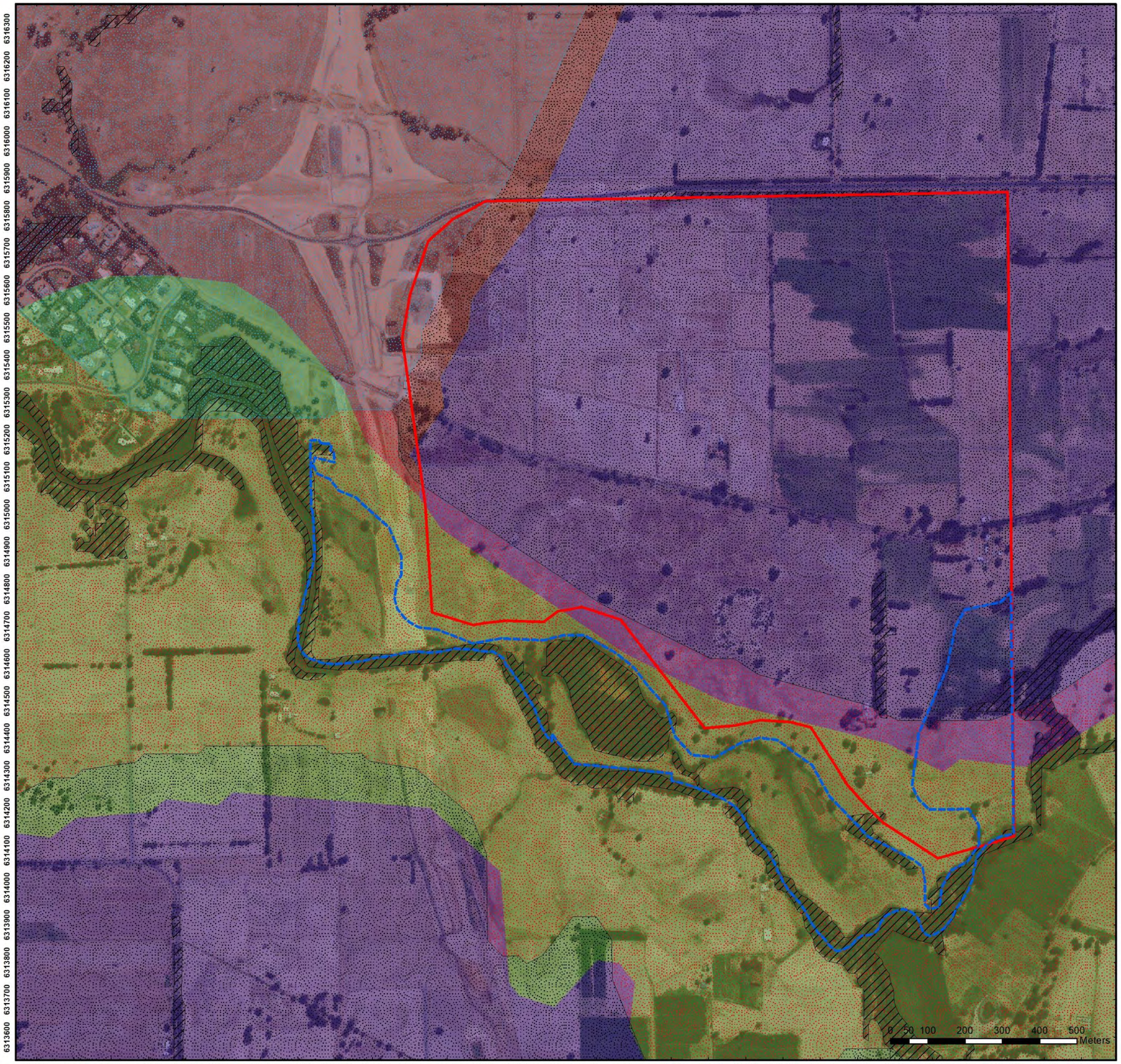
Treendale Structure Plan
Roelands, WA 6226

Map 2: Wetlands & Floodplain Mapping

STATUS	*FILE*	*DATE*
FINAL	**MSC0285-002**	**4/08/2022**



Overview Map Scale 1:250,000

Legend

- Native Vegetation Extent (DPIRD-005)

Vegetation Complexes- Swan Coastal Plain (DBCA-046)

- Guildford Complex
- Southern River Complex
- Swan Complex

Pre_European Vegetation (DPIRD-006)

- BASSENDEAN_1000
- PINJARRA_1182
- PINJARRA_968

Scale
1:10,000@ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2016
Cadastre and Contours: Landgate 2016
Overview Map: World Topographic map service, ESRI 2012

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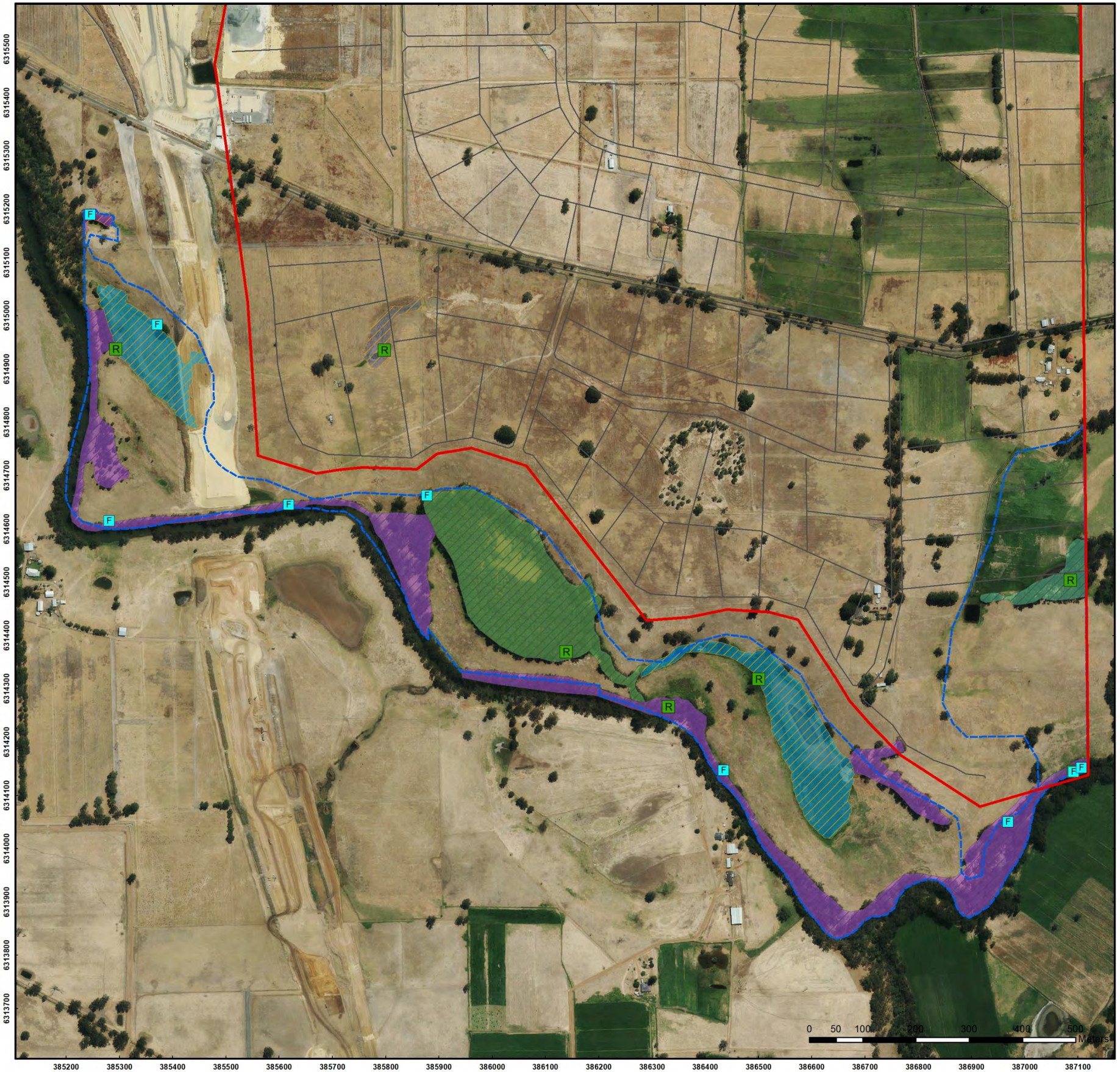
Map 3: Historic Vegetation Mapping

STATUS	*FILE*	*DATE*
FINAL	**MSC0285-002**	**04/08/2022**



Overview Map Scale 1:100,000

Legend

- Subject Site
- Survey Area
- Cadastre
- 5m Contours
- Proposed lot layout
- R Releve Sites
- F Eucalyptus rudis subsp cratyantha P4

Vegetation Mapping

- C. calophylla open woodland
- E. rudis and C. calophylla woodland
- Isolated E. rudis trees over J. subsecundus grassland
- J. subsecundus, J.sp. and C. clandestinus grassland
- M. rhaphiophylla, E. rudis and C. calophylla forest

Vegetation Condition

- Completely Degraded
- Degraded

Scale
1:7,000 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2016
Cadastre and Contours: Landgate 2016
Overview Map: World Topographic map service, ESRI 2012

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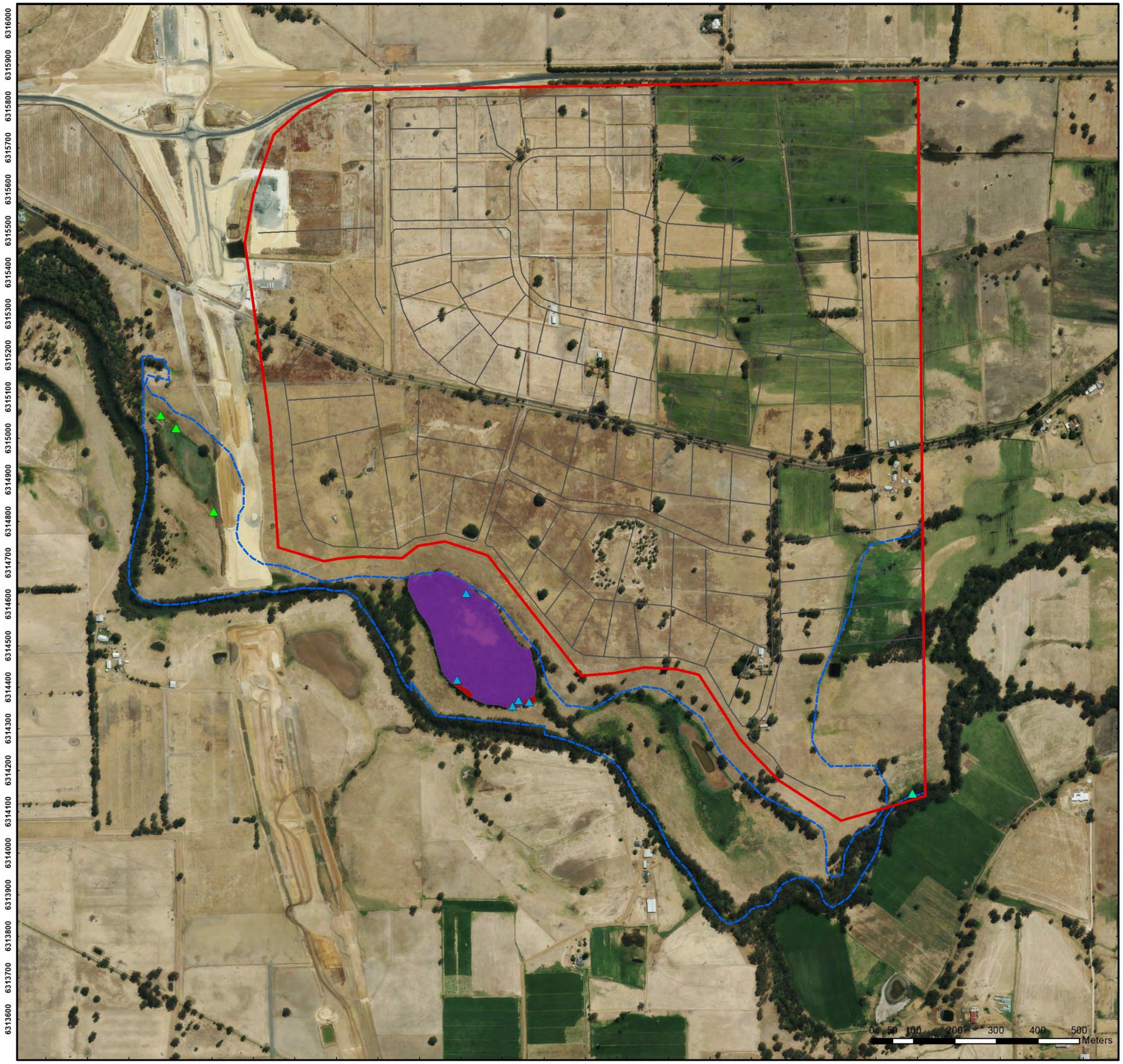
Map 4: Vegetation Mapping

STATUS	*FILE*	*DATE*
FINAL	**MSC0285-002**	**04/08/2022**



Overview Map Scale 1:100,000

Legend

- Subject Site
- Survey Area
- Cadastre
- 5m Contours
- Proposed lot layout

Weed infestations

- Phytolacca octandra - Throughout wetland
- Rubus ulmifolius

Declared Weeds

- Asparagus asparagoides
- Gomphocarpus fruticosus
- Rubus ulmifolius
- Solanum linnaeanum

Scale
1:9,000 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2016
Cadastre and Contours: Landgate 2016
Overview Map: World Topographic map service, ESRI 2012

CLIENT
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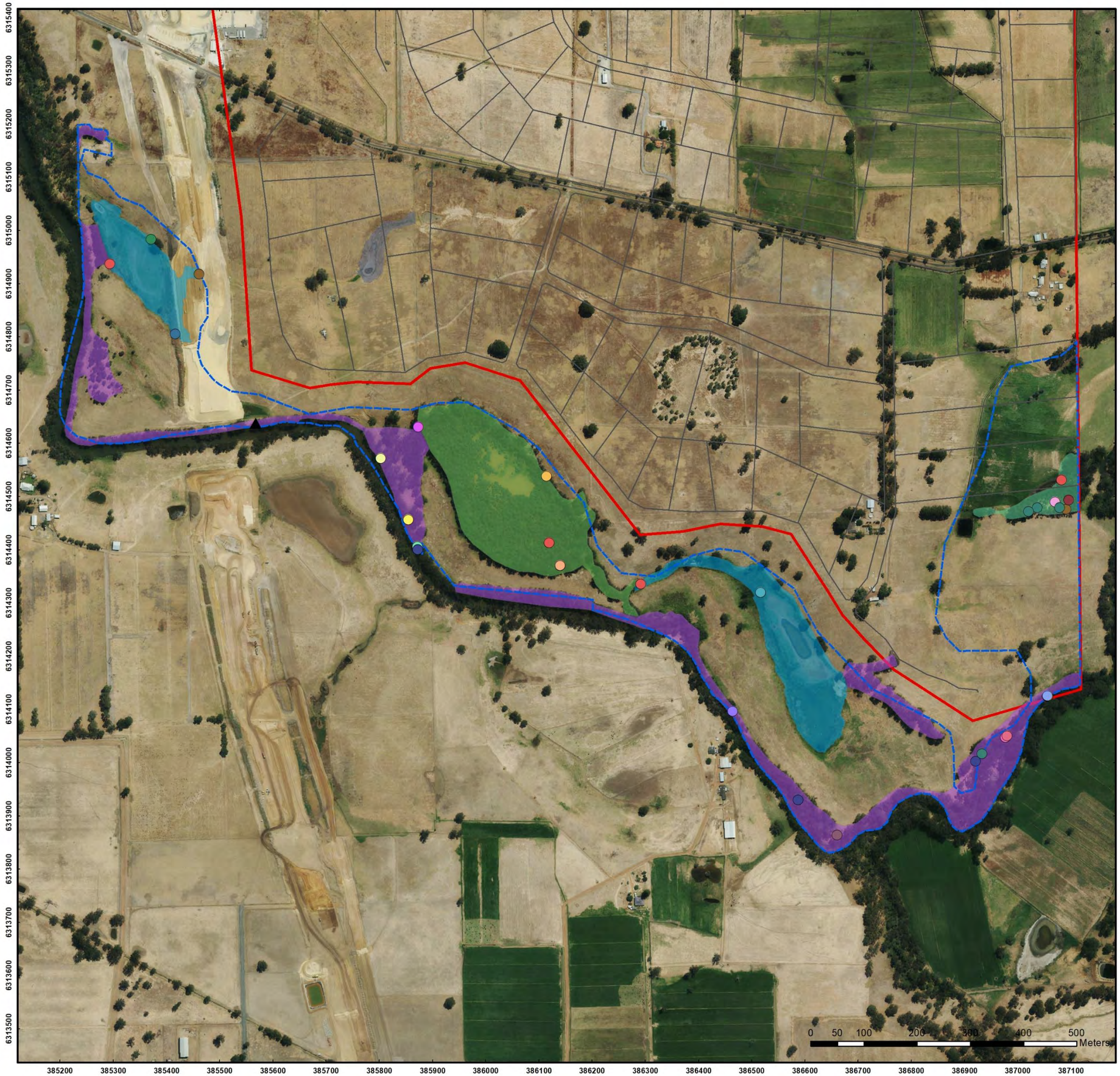
Map 5: Weed Mapping

STATUS	*FILE*	*DATE*
FINAL	**MSC0285-002**	**04/08/2022**



Overview Map Scale 1:250,000

Legend

Subject Site

Survey Area

Vegetation Mapping

- C. calophylla open woodland
- E. rudis and C. calophylla woodland
- Isolated E. rudis trees over J. subsecundus grassland
- J. subsecundus, J.sp. and C. clandestinus grassland
- M. rhaphiophylla, E. rudis and C. calophylla forest

Fauna

- Anas superciliosa
- Anthochaera carunculata
- Calyptorhynchus banksii naso (VU)
- Chenonetta jubata
- Corvus coronoides
- Cracticus tibicen
- Cygnus atratus
- Dacelo novaeguineae
- Eolophus roseicapilla
- Eopsaltria georgiana
- Falco cenchroides
- Fulica atra
- Geocrinia leai
- Gerygone fusca
- Grallina cyanoleuca
- Macropus fuliginosus
- Pachycephala pectoralis
- Petrochelidon nigricans
- Platycercus icterotis
- Platycercus spurius
- Platycercus zonarius
- Rhipidura albiscapa
- Smicrornis brevirostris
- Tadorna tadornoides
- Trichosurus vulpecula subsp. vulpecula
- Vulpes vulpes

Fauna Habitat

▲ Small Hollow - Arboreal Mammal

Scale
1:7,000 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2016
Cadastre and Contours: Landgate 2016
Overview Map: World Topographic map service, ESRI 2012

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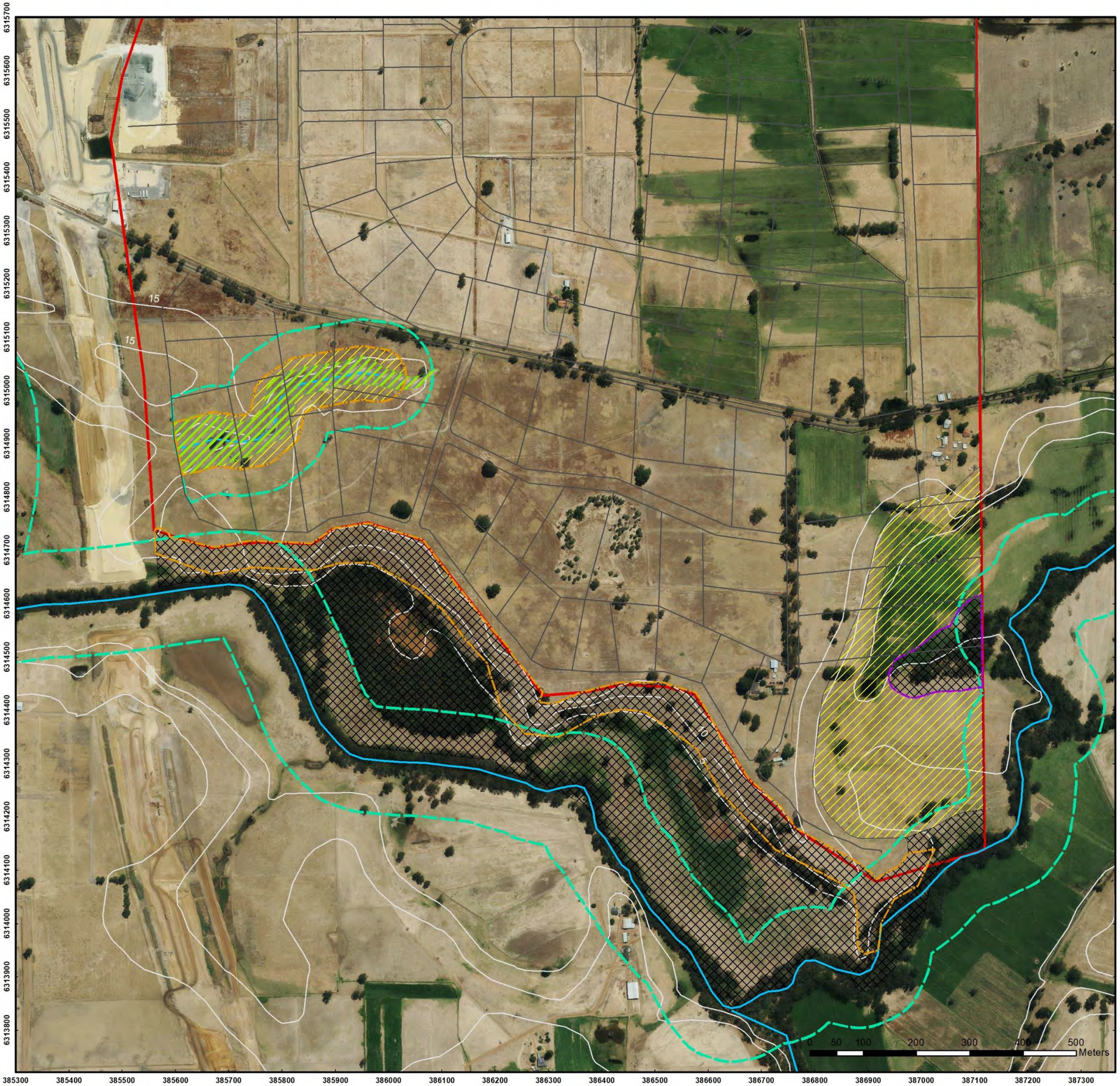
Roelands, WA 6226

Map 6: Fauna Values

STATUS	*FILE*	*DATE*
FINAL	**MSC0285-002**	**04/08/2022**



29 Hercules Crescent
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Australia

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Fax: 08 9842 1575

Overview Map Scale 1:250,000

Legend

- Cadastre
- 5m Contours
- Proposed Development Exclusion Area
- Proposed Foreshore Reserve

Wetland Buffers

- 50
- 30
- Setback to onsite effluent disposal (100m)

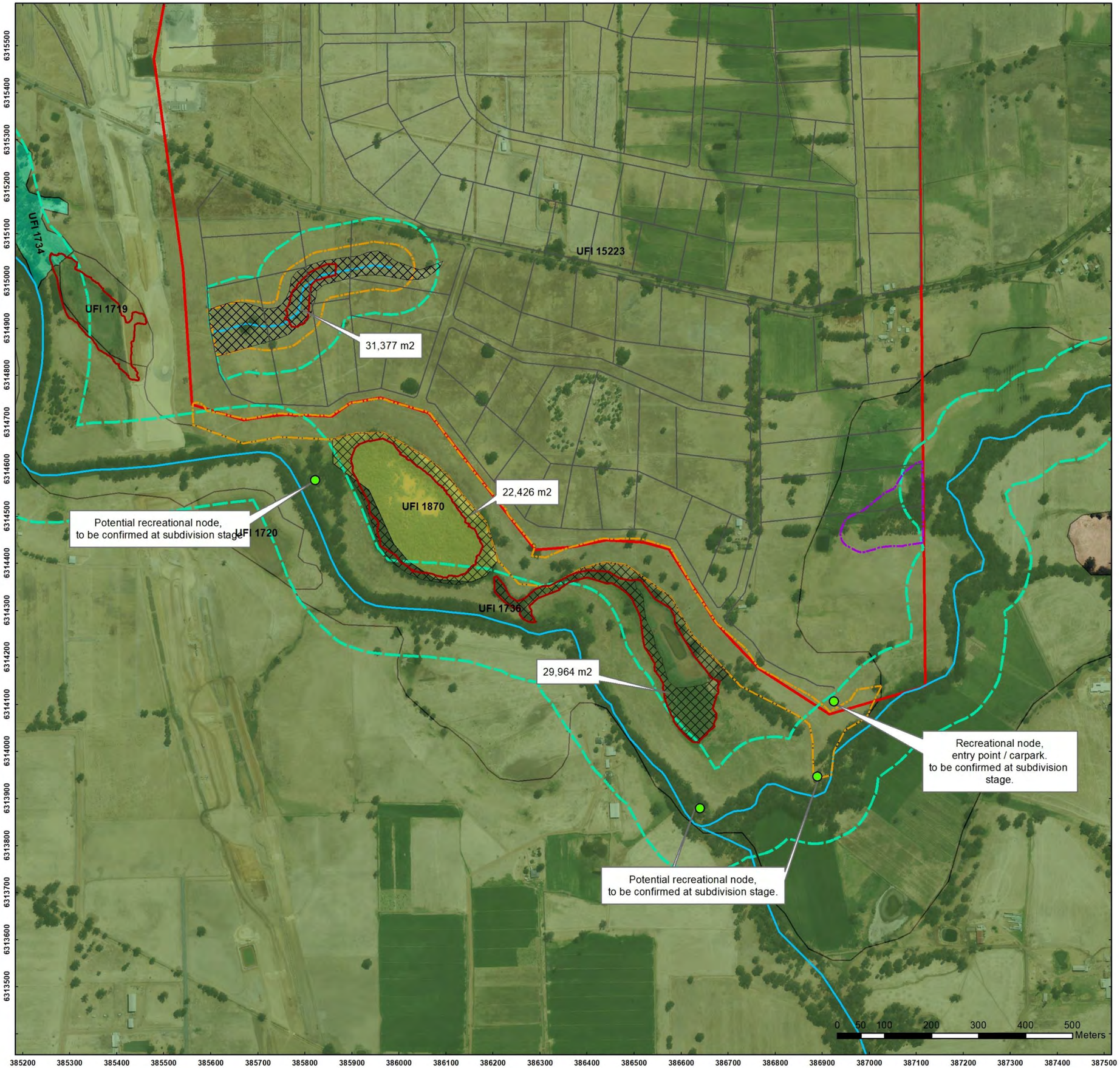
Scale
1:7,000 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2016
Cadastre and Contours: Landgate 2016
Overview Map: World Topographic map service, ESRI 2012

CLIENT
TECON Australia
Treendale Structure Plan
Roelands, WA 6226

Map 7: Proposed Foreshore Area

STATUS	*FILE*	*DATE*
FINAL	**MSC0285-002**	**15/07/2020**



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Overview Map Scale 1:250,000

Legend

- Cadastre
- 5m Contours
- Revegetation Areas
- Edge Riparian Vegetation (in field)

Geomorphic Wetlands Swan Coastal Plain(DBCA_019)

- Conservation
- Multiple Use
- Not Applicable
- Not Assessed
- Resource Enhancement

Wetland Buffers

- 50
- 30
- Setback to onsite effluent disposal (100m)

Scale
1:7,902 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: SLIP Virtual Mosaic WMS Service, Landgate 2016
Cadastre and Contours: Landgate 2016
Overview Map: World Topographic map service, ESRI 2012

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Map 8: Revegetation Areas

STATUS	*FILE*	*DATE*
FINAL	**MSC0285-002**	**27/07/2020**

Appendix B

Flora and Fauna Species Lists and Relevé Data

Table A1: Flora species recorded within Survey Area
Presented in alphabetical order of family, then scientific name). P4= Priority 4, *= Pest/introduced species.

Family	Scientific Name	Common Name	Cons Status
Apiaceae	Foeniculum vulgare	Fennel	*
Apocynaceae	Gomphocarpus fruticosus	Narrowleaf Cottonbush	*
Asparagaceae	Asparagus asparagoides	Bridal Creeper	*
Asteraceae	Cirsium sp.		*
Asteraceae	Cirsium vulgare	Spear Thistle	*
Asteraceae	Conyza sp.		*
Asteraceae	Cotula sp. (bipinnata ?)		*
Asteraceae	Cotula sp. (coronopifolia ?)		*
Brassicaceae	Rorippa nasturtium-aquaticum	Watercress	*
Iridaceae	Watsonia sp.		*
Juncaceae	Juncus sp.		
Juncaceae	Juncus subsecundus	Finger Rush	
Lauraceae	Cassytha glabella	Tangled Dodder Laurel	
Moraceae	Ficus carica	Common Fig	*
Myrtaceae	Agonis flexuosa	Peppermint	
Myrtaceae	Corymbia calophylla	Marri	
Myrtaceae	Eucalyptus gomphocephala	Tuart	
Myrtaceae	Eucalyptus marginata	Jarrah	
Myrtaceae	Eucalyptus rudis	Flooded Gum	
Myrtaceae	Eucalyptus rudis subsp. cratyantha	Large-flowered Flooded Gum	P4
Myrtaceae	Melaleuca rhaphiophylla	Swamp Paperbark	
Oleaceae	Olea europaea	Olive	*
Oxalidaceae	Oxalis pes-caprae	Soursob	*
Phytolaccaceae	Phytolacca octandra	Red Ink Plant	*
Poaceae	Briza maxima	Blowfly Grass	*
Poaceae	Briza minor	Shivery Grass	*
Poaceae	Bromus diandrus	Great Brome	*
Poaceae	Cenchrus clandestinus	Kikuyu	*
Poaceae	Cynodon dactylon	Couch	*
Poaceae	Holcus lanatus	Yorkshire Fog	*
Poaceae	Lolium perenne	Perennial Ryegrass	*
Polygonaceae	Rumex pulcher	Fiddle Dock	*
Rosaceae	Rubus ulmifolius	Blackberry	*
Solanaceae	Solanum linnaeanum	Apple of Sodom	*
Solanaceae	Solanum nigrum	Black Berry Nightshade	*
	Unidentified Aquatic weed (?)		*

Relevé	R01	Veg Code	Corcal	Date Surveyed	25th June 2020
Location	Eastern boundary of survey area				
GPS (WGS 84)	33° 18' 9.541" S			115° 47' 13.784" E	
Landform and Slope	Hill slope				
Soils	Brown loam				
Vegetation description	Corymbia calophylla woodland over Cenchrus clandestinus, Lolium perenne, Bromus diandrus, Briza maxima and B. minor grassland.				
Condition	Degraded				
Comments					

Life Form	Dominant Species	Other Species	Cover (%)
Trees >10m	Corymbia calophylla		30-70
Grass	Cenchrus clandestinus	Lolium perenne, Bromus diandrus, Briza maxima and Briza minor	>70


N
NE
E
SE
0
30
60
90
120
150
77°E (T) 33°18'10"S, 115°47'12"E ±25m 15m
25 Jun 2020, 11:50:52

Relevé	R02	Veg Code	Eucrud/Corcal	Date Surveyed	25th June 2020
Location	South eastern boundary of survey area				
GPS (WGS 84)	33° 18' 21.207" S			115° 47' 13.820" E	
Landform and Slope	Floodplain				
Soils	Dark brown loam				
Vegetation description	Eucalyptus rudis & Corymbia calophylla woodland, over mixed introduced grass and herb grassland.				
Condition	Degraded				
Comments					

Life Form	Dominant Species	Other Species	Cover (%)
Trees >10m	Eucalyptus rudis	Corymbia calophylla	>70
Trees <10m		Melaleuca rhaphiophylla, Agonis flexuosa	2-10
Grass	Cenchrus clandestinus		>70
Herb		Oxalis pes-caprae, Rubus ulmifolius, Watsonia sp.	<2

Relevé	R03	Veg Code	EucRud/Junsub	Date Surveyed	25th June 2020
Location	Central of the survey area				
GPS (WGS 84)	33° 18' 15.364" S			115° 46' 51.065" E	
Landform and Slope	Seasonally inundated floodplain				
Soils	Brown clay/loam				
Vegetation description	Isolated Eucalyptus. rudis trees over Juncus subsecundus and mixed introduced grassland				
Condition	Completely Degraded				
Comments					

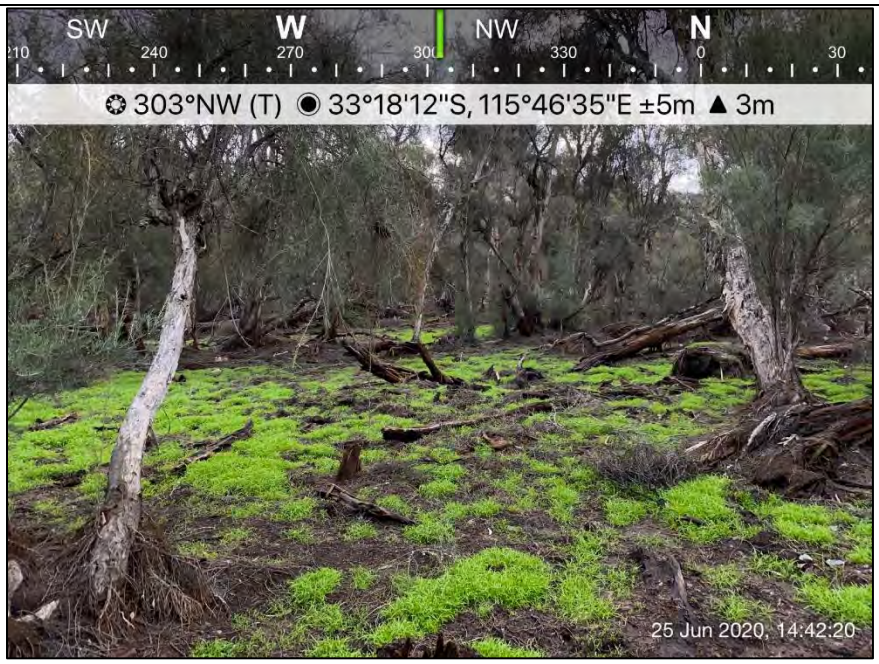
Life Form	Dominant Species	Other Species	Cover (%)
Trees >10m		Eucalyptus rudis	<2
Sedge	Juncus subsecundus	Juncus sp.	10-30
Grass	Cenchrus clandestinus		30-70
Herb		Cirsium vulgare, Rorippa nasturtium-aquaticum	<2

Relevé	R04	Veg Code	Eucrud/Corca	Date Surveyed	25th June 2020
Location	Central of the survey area				
GPS (WGS 84)	33° 18' 16.987" S			115° 46' 44.500" E	
Landform and Slope	Floodplain				
Soils	Dark brown loam				
Vegetation description	Eucalyptus rudis & Corymbia calophylla woodland, over mixed introduced grass and herb grassland.				
Condition	Degraded				
Comments					

Life Form	Dominant Species	Other Species	Cover (%)
Trees >10m	Eucalyptus rudis	Corymbia calophylla, Eucalyptus gomphocephala	10-30
Trees <10m	Agonis flexuosa		30-70
Grass	Cenchrus clandestinus		>70
Herb		Oxalis pes-caprae, Rubus ulmifolius, Watsonia sp.	<2

Relevé	R05	Veg Code	Melrha	Date Surveyed	25th June 2020
Location	Central of the survey area				
GPS (WGS 84)	33° 18' 13.566" S			115° 46' 37.100" E	
Landform and Slope	Wetland - seasonally inundated				
Soils	Red/brown clay/loam				
Vegetation description	Melaleuca rhaphiophylla, Eucalyptus rudis and Corymbia calophylla forest over very open introduced herbs and grasses				
Condition	Degraded				
Comments	Lots of overstorey canopy species death throughout the wetland				

Life Form	Dominant Species	Other Species	Cover (%)
Trees >10	Melaleuca rhaphiophylla	Eucalyptus rudis and Corymbia calophylla	10-30
Trees <10m	Melaleuca rhaphiophylla		>70
Grass		Cenchrus clandestinus	2-10
Herb	Cotula sp. (bipinnata?) Rubus ulmifolius,	Phytolacca octandra, Cotula sp. (coronopifolia?), Conyza sp., Cassytha glabella,	10-30


SW
W
NW
N
210
240
270
300
330
0
30
303°NW (T) 33°18'12"S, 115°46'35"E ±5m ▲ 3m
25 Jun 2020, 14:42:20

Relevé	R06	Veg Code	EucRud/Junsub	Date Surveyed	26th June 2020
Location	Western boundary of the survey area				
GPS (WGS 84)	33° 17' 54.778" S			115° 46' 4.670" E	
Landform and Slope	Wetland - seasonally inundated				
Soils	Brown clay/loam				
Vegetation description	Isolated Eucalyptus. rudis trees over Juncus subsecundus and mixed introduced grassland				
Condition	Completely Degraded				
Comments					

Life Form	Dominant Species	Other Species	Cover (%)
Trees >10m		Eucalyptus rudis	<2
Sedge	Juncus subsecundus	Juncus sp.	>70
Grass	Cenchrus clandestinus		30-70

Relevé	R07	Veg Code	Junsub	Date Surveyed	26th June 2020
Location	South of Treendale Road, in grazed paddock area				
GPS (WGS 84)	33° 17' 55.046" S			115° 46' 24.163" E	
Landform and Slope	Plain, slope flat				
Soils	Pale sand over yellow/orange clay				
Vegetation description	Juncus subsecundus, Juncus sp. and Cenchrus clandestinus grassland				
Condition	Completely degraded				
Comments					

Life Form	Dominant Species	Other Species	Cover (%)
Sedge	Juncus subsecundus	Juncus sp.	10-30
Herb	Cenchrus clandestinus		>70

Table A2: Fauna species recorded within survey area

Family	Taxon Name	Vernacular
Birds		
Acanthizidae	Smicrornis brevirostris	weebill
Acanthizidae	Gerygone fusca	western gerygone
Anatidae	Anas superciliosa	Pacific black duck
Anatidae	Cygnus atratus	black swan
Anatidae	Tadorna tadornoides	Australian shelduck
Anatidae	Chenonetta jubata	wood duck
Cacatuidae	Eolophus roseicapilla	galah
Corvidae	Corvus coronoides	Australian raven
Cracticidae	Cracticus tibicen	Australian magpie
Dicruridae	Rhipidura albiscapa	grey fantail
Dicruridae	Grallina cyanoleuca	magpie-lark
Falconidae	Falco cenchroides	nankeen kestrel
Halcyonidae	Dacelo novaeguineae	laughing kookaburra
Hirundinidae	Petrochelidon nigricans	tree martin
Meliphagidae	Anthochaera carunculata	red wattlebird
Pachycephalidae	Pachycephala pectoralis	western whistler
Petroicidae	Eopsaltria georgiana	white-breasted robin
Psittacidae	Platycercus zonarius	Australian ringneck parrot
Psittacidae	Platycercus spurius	red-capped parrot
Psittacidae	Platycercus icterotis	western rosella
Rallidae	Fulica atra	Eurasian coot
Cacatuidae	Calyptorhynchus banksii naso (VU)	Forest red-tailed black cockatoo (VU)
Mammals		
Canidae	Vulpes vulpes	fox
Macropodidae	Macropus fuliginosus	western grey kangaroo
Phalangeridae	Trichosurus vulpecula subsp. vulpecula	common brushtail possum
Frogs		
Myobatrachidae	Geocrinia leai	ticking frog

Appendix C

Conservation Significant Values Likelihood of Occurrence Analysis

Table A3: Criteria for assessing the likelihood of occurrence of conservation significant flora within a 10km radius of the survey area.

Likelihood	Criteria
Present	Species is recorded within the Survey Area.
Likely	Species has been previously recorded in close proximity and suitable habitat occurs within the Survey Area.
Possible	Species previously recorded within 10 km and suitable habitat occurs in the Survey Area.
Unlikely	Suitable habitat for the species does not occur at the Survey Area OR Suitable habitat may occur but the species has a highly restricted distribution, is very rare and only known from a limited number of populations.
Highly Unlikely	The Survey Area is outside the species' natural distribution.

Table A4: Potential conservation significant flora located within 20km of the Survey Area and likelihood of occurrence analysis (pre and post survey).

Family	Species	Conservation Code	Description	Flowering period	Likelihood of occurrence Pre survey	Likelihood of occurrence Post survey	Comments
Apiaceae	Brachyscias verecundus	T	Annual (or ephemeral), herb, 0.012-0.022 m high, entirely glabrous. Fl. White/cream. In a moss sward. On a granite outcrop.	N/A	Highly Unlikely	Highly Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Apiaceae	Platysace ramosissima	P3	Perennial, herb, to 0.3 m high. Fl. White-cream, Oct to Nov. Sandy soils.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Aponogetonaceae	Aponogeton hexatepalus	P4	Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. Green-white, Jul to Oct. Mud. Freshwater: ponds, rivers, claypans.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Asteraceae	Angianthus drummondii	P3	Erect annual, herb, to 0.1 m high. Fl. Yellow, Oct to Dec. Grey or brown clay soils, ironstone. Seasonally wet flats.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Asteraceae	Craspedia sp. Waterloo (G.J. Keighery 13724)	P2	N/A	N/A	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Asteraceae	Senecio leucoglossus	P4	Erect annual, herb, to 1.3 m high. Fl. White, Aug to Dec. Gravelly lateritic or granitic soils. Granite outcrops, slopes.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Celastraceae	Tripterococcus sp. Brachylobus (A.S. George 14234)	P4	Perennial, herb, to 1 m high. Fl. Yellow/yellow-green. Grey sand, red clay, laterite, often moist. Low-lying flats.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Cyperaceae	Carex tereticaulis	P3	Monoecious, rhizomatous, tufted perennial, grass-like or herb (sedge), 0.7 m high. Fl. Brown, Sep to Oct. Black peaty sand.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Cyperaceae	Caustis sp. Boyanup (G.S. McCutcheon 1706)	P3	Rhizomatous, clumped perennial, grass-like or herb (sedge), 0.7-1 m high. White or grey sand.	N/A	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Cyperaceae	Cyathochaeta teretifolia	P3	Rhizomatous, clumped, robust perennial, grass-like or herb (sedge), to 2 m high, to 1.0 m wide. Fl. Brown. Grey sand, sandy clay. Swamps, creek edges.	N/A	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Cyperaceae	Eleocharis keigheryi	T	Rhizomatous, clumped perennial, grass-like or herb (sedge), to 0.4 m high. Fl. Green, Aug to Nov. Clay, sandy loam. Emergent in freshwater: creeks, claypans.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.

Table A4 continued.

Family	Species	Conservation Code	Description	Flowering period	Likelihood of occurrence Pre survey	Likelihood of occurrence Post survey	Comments
Cyperaceae	Schoenus benthamii	P3	Tufted perennial, grass-like or herb (sedge), 0.15-0.45 m high. Fl. Brown, Oct to Nov. White, grey sand, sandy clay. Winter-wet flats, swamps.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Cyperaceae	Schoenus capillifolius	P3	Semi-aquatic tufted annual, grass-like or herb (sedge), 0.05 m high. Fl. Green, Oct to Nov. Brown mud. Claypans.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Cyperaceae	Schoenus loliaceus	P2	Annual, grass-like or herb (sedge), 0.03-0.06 m high. Fl. Aug to Nov. Sandy soils. Winter-wet depressions.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Ericaceae	Andersonia gracilis	T	Slender erect or open straggly shrub, 0.1-0.5(-1) m high. Fl. White-pink-purple, Sep to Nov. White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps.	N	Likely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Ericaceae	Leucopogon sp. Busselton (D. Cooper 243)	P2	Slender, erect shrub to 70 cm; Fl. White, Aug to Sep. Pericalymma ellipticum wet shrubland, Marri-Jarrah woodland.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Fabaceae	Acacia flagelliformis	P4	Rush-like, erect or sprawling shrub, 0.3-0.75(-1.6) m high. Fl. Yellow, May to Sep. Sandy soils. Winter-wet areas.	Y	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Fabaceae	Acacia oncinophylla subsp. oncinophylla	P3	Shrub, 0.9-2.5 m high, 'minni-ritchi' bark, phyllodes mostly 8-13 cm long, 1-2 mm wide. Fl. Yellow, Aug to Oct. Granitic soils.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Fabaceae	Acacia semitrullata	P4	Slender, erect, pungent shrub, (0.1-)0.2-0.7(-1.5) m high. Fl. Cream-white, May to Oct. White/grey sand, sometimes over laterite, clay. Sandplains, swampy areas.	Y	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Fabaceae	Acacia sp. Binningup (G. Cockerton et al. WB 37784)	P1	Shrub, sand.	N/A	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Fabaceae	Dillwynia dillwynioides	P3	Decumbent or erect, slender shrub, 0.3-1.2 m high. Fl. Red & yellow/orange, Aug to Dec. Sandy soils. Winter-wet depressions.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Fabaceae	Gastrolobium sp. Yoongarillup (S.Dilkes s.n. 1/9/1969)	P1	Jarrah-Marri forest, white sand, gravel, Fl. Aug to Oct.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.

Table A4 continued.

Family	Species	Conservation Code	Description	Flowering period	Likelihood of occurrence Pre survey	Likelihood of occurrence Post survey	Comments
Fabaceae	Gastrolobium whicherense	P2	Slender, open shrub, to 1.6 m high. Fl. Orange/yellow/red, Oct. Red-grey sandy clay over quartzite. Steep westerly slopes.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Fabaceae	Pultenaea skinneri	P4	Slender shrub, 1-2 m high. Fl. Yellow/orange & red, Jul to Sep. Sandy or clayey soils. Winter-wet depressions.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Juncaceae	Juncus meianthus	P3	Tufted perennial, herb, 0.05-0.2 m high, to 0.4 m wide. Fl. Brown, Nov to Dec or Jan. Black sand, sandy clay. Creeks, seepage areas.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Loganiaceae	Adelphacme minima	P3	Annual 10-20 cm tall. Fl. White. Swamp. Grey sand/loam.	N/A	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Loganiaceae	Orianthera wendyae	P1	Typically associated with Ridge top; Brown lateritic sandy clay soil type.	N/A	Highly unlikely	Highly unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Malvaceae	Lasiopetalum laxiflorum	P3	Multi-stemmed, straggling, viscid, subshrub to shrub 0.3–1.5 m high, 0.2–1.5 m wide. restricted to the Whicher Range area. Eucalyptus marginata, Corymbia, Allocasuarina or Banksia grandis woodland or forest, in gravelly, brown clay over laterite, rarely in white sand.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Malvaceae	Lasiopetalum membranaceum	P3	Multi-stemmed shrub, 0.2-1 m high. Fl. Pink-blue-purple, Sep to Dec. Sand over limestone.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Malvaceae	Lomandra whicherensis	P3	Tufted rhizomatous herb, 20 cm high, 30 cm wide. Jarrah-marri forest, lateritic soils, sandy clay.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Menyanthaceae	Ornduffia submersa	P4	N/A	N/A	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Myrtaceae	Chamelaucium erythrochlorum	P4	Shrub to 2m high. Fl. Red, Sep to Jun, lateritic soils.	Y	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Myrtaceae	Chamelaucium sp. S coastal plain (R.D.Royce 4872) Now Chamelaucium roycei	T	Shrub to 1.2m high. Fl. White to pale pink, Sep to Dec. Winter-wet swamps or fringing watercourses.	N	Highly Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.

Table A4 continued.

Family	Species	Conservation Code	Description	Flowering period	Likelihood of occurrence Pre survey	Likelihood of occurrence Post survey	Comments
Myrtaceae	Darwinia whicherensis	T	erect or sometimes spreading shrub, up to 70 cm tall by 40 cm wide, winter-wet area of shrubland over shallow red clay over ironstone.	N	Highly unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Myrtaceae	Eucalyptus rudis subsp. cratyantha	P4	Tree, 5-20 m high, bark rough, box-type. Fl. White, Jul to Sep. Loam. Flats, hillsides.	N	Present. Previously recorded (360)	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Myrtaceae	Verticordia attenuata	P3	Shrub, 0.4-1 m high. Fl. Pink, Dec or Jan to May. White or grey sand. Winter-wet depressions.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Orchidaceae	Caladenia huegelii	T	Tuberous, perennial, herb, 0.25-0.6 m high. Fl. Green & cream & red, Sep to Oct. Grey or brown sand, clay loam.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Orchidaceae	Caladenia procera	T	Tuberous, perennial, herb, 0.35-0.9 m high. Fl. yellow, Sep to Oct. Rich clay loam, Alluvial loamy flats, jarrah/marri/peppermint woodland, dense heath, Osedges.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Orchidaceae	Caladenia speciosa	P4	Tuberous, perennial, herb, 0.35-0.6 m high. Fl. White-pink, Sep to Oct. White, grey or black sand.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Orchidaceae	Diuris drummondii	T	Tuberous, perennial, herb, 0.5-1.05 m high. Fl. Yellow, Nov to Dec or Jan. Low-lying depressions, swamps.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Orchidaceae	Diuris micrantha	T	Tuberous, perennial, herb, 0.3-0.6 m high. Fl. Yellow & brown, Sep to Oct. Brown loamy clay. Winter-wet swamps, in shallow water.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Orchidaceae	Diuris purdiei	T	Tuberous, perennial, herb, 0.15-0.35 m high. Fl. Yellow, Sep to Oct. Grey-black sand, moist. Winter-wet swamps.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Orchidaceae	Drakaea elastica	T	Tuberous, perennial, herb, 0.12-0.3 m high. Fl. red & green & yellow, Oct to Nov. White or grey sand. Low-lying situations adjoining winter-wet swamps.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Orchidaceae	Drakaea micrantha	T	Tuberous, perennial, herb, 0.15-0.3 m high. Fl. Red & yellow, Sep to Oct. White-grey sand.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.

Table A4 continued.

Family	Species	Conservation Code	Description	Flowering period	Likelihood of occurrence Pre survey	Likelihood of occurrence Post survey	Comments
Orchidaceae	Pterostylis frenchii	P2	Tuberous, herb, to 0.35 m high, with rosette leaves, Nov to Dec. Calcareous sand with limestone, laterite. Flatlands and gentle slopes.	N	Highly unlikely	Highly unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Orchidaceae	Thelymitra variegata	P2	Tuberous, perennial, herb, 0.1-0.35 m high. Fl. Orange & red & purple & pink, Jun to Sep. Sandy clay, sand, laterite.	Y	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Poaceae	Austrostipa bronwenae	T	perennial, rhizomatous grass to 1.5m high. Grey-brown sandy loam or dark brown loam over clay in low-lying winter wet areas.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Poaceae	Austrostipa jacobsiana	T	perennial rhizomatous grass to 1.2 metres tall. Sandy-loam over lime-marl rock in a seasonal dampland.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Poaceae	Puccinellia vassica	P1	Caespitose annual or perennial, grass-like or herb, 0.41-0.55 m high. Saline soils. On the outer margins of coastal saltmarshes.	N/A	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Polygonaceae	Rumex drummondii	P4	Erect perennial, herb, 0.6-0.9 m high. Winter-wet disturbed areas.	N/A	Likely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Banksia nivea subsp. uliginosa	T	Dense, erect, non-lignotuberous shrub, 0.2-1.5 m high. Fl. Yellow-brown, Aug to Sep. Sandy clay, gravel.	N	Highly Unlikely	Highly Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Banksia squarrosa subsp. argillacea	T	Erect, open, non-lignotuberous shrub, 1.2-4 m high. Fl. Yellow, Jun to Nov. White/grey sand, gravelly clay or loam. Winter-wet flats, clay flats.	Y	Highly Unlikely	Highly Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Franklandia triaristata	P4	Erect, lignotuberous shrub, 0.2-1 m high. Fl. White-cream-yellow/brown-purple, Aug to Oct. White or grey sand.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Grevillea rosieri	P2	Shrub. Fl. Red, Jul or Sep. Sandy soils.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Lambertia echinata subsp. occidentalis	T	Prickly, much-branched, non-lignotuberous shrub, to 3 m high. Fl. Yellow, Feb or Apr or Dec. White sandy soils over laterite, orange/brown-red clay over ironstone. Flats to foothills, winter-wet sites.	N	Highly Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.

Table A4 continued.

Family	Species	Conservation Code	Description	Flowering period	Likelihood of occurrence Pre survey	Likelihood of occurrence Post survey	Comments
Proteaceae	Synaphea hians	P3	Prostrate or decumbent shrub, 0.15-0.6 m high, to 1 m wide. Fl. Yellow, Jul or Sep to Nov. Sandy soils. Rises.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Synaphea odocoileops	P1	Tufted, compact shrub, 0.2-0.5 m high. Fl. Yellow, Aug to Oct. Brown-orange loam & sandy clay, granite. Swamps, winter-wet areas.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Synaphea polypodioides	P3	Clumped shrub (sunshrub), 0.35-0.4 m high, Sep to Oct. Light brown loam, red-brown sandy loam, gravelly, brown sandy clay over laterite. In undulating areas.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Synaphea sp. Fairbridge Farm (D. Papenfus 696)	T	Dense, clumped shrub, to 0.3 m high, to 0.4 m wide. Fl. Yellow, Oct. Sandy with lateritic pebbles. Near winter-wet flats, in low woodland with weedy grasses.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Synaphea sp. Serpentine (G.R. Brand 103)	T	N/A	N/A	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Proteaceae	Synaphea stenoloba	T	Caespitose shrub, 0.3-0.45 m high. Fl. Yellow, Aug to Oct. Sandy or sandy clay soils. Winter-wet flats, granite.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Rutaceae	Boronia capitata subsp. gracilis	P3	Slender shrub, 0.3-0.6(-3) m high, branches pilose. Fl. Pink, Jun to Nov. White/grey or black sand. Winter-wet swamps, hillslopes.	Y	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Rutaceae	Boronia juncea subsp. juncea	P1	Slender or straggly shrub, pedicels and sepals glabrous. Fl. Pink, Apr. Sand. Low scrub.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Rutaceae	Boronia tenuis	P4	Procumbent or erect & slender shrub, 0.1-0.5 m high. Fl. Blue/pink-white, Aug to Nov. Laterite, stony soils, granite.	N	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Rutaceae	Boronia tetragona	P3	Perennial, herb, 0.3-0.7 m high, leaves sessile, entire, with papillate margins, branches quadrangular, sepals ciliate. Fl. Pink & red, Oct to Dec. Black/white sand, laterite, brown sandy loam. Winter-wet flats, swamps, open woodland.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Santalaceae	Leptomeria furtiva	P2	Lax, sprawling shrub, 0.2-0.45 m high. Fl. Orange-brown, Aug to Oct. Grey or black peaty sand. Winter-wet flats.	N	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.

Table A4 continued.

Family	Species	Conservation Code	Description	Flowering period	Likelihood of occurrence Pre survey	Likelihood of occurrence Post survey	Comments
Stylidiaceae	Stylidium acuminatum subsp. acuminatum	P2	N/A	N/A	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Stylidiaceae	Stylidium longitubum	P4	Erect annual (ephemeral), herb, 0.05-0.12 m high. Fl. Pink, Oct to Dec. Sandy clay, clay. Seasonal wetlands.	Oct to Dec	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Stylidiaceae	Stylidium paludicola	P3	Reed-like perennial, herb, 0.35-1 m high, Leaves tufted, linear or subulate or narrowly oblanceolate, 0.5-4 cm long, 0.5-1.5 mm wide, apex acute, margin entire, glabrous. Scape mostly glabrous, inflorescence axis glandular. Inflorescence racemose. Fl. Pink, Oct to Dec. Peaty sand over clay. Winter wet habitats. Marri and Melaleuca woodland, Melaleuca shrubland.	Oct to Dec	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Stylidiaceae	Stylidium perplexum	P1	Brown lateritic sands	Dec	Unlikely	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.
Xanthorrhoeaceae	Chamaescilla gibsonii	P3	Clumped tuberous, herb. Fl. Blue, Sep. Clay to sandy clay. Winter-wet flats, shallow water-filled claypans.	Sep	Possible	Unlikely	The survey area has been altered through current agricultural purposes, with clearing and cattle grazing evident through the lack of mid and understorey species. No areas of high-quality remnant vegetation remain in the survey area. Given the lack of vegetation and high levels of disturbance it is unlikely the species is present.

Table A5: Potential threatened and priority ecological communities located within 10km of the survey area.

Name	Status	Description	Likelihood of occurrence
Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region	P3 / EN	Canopy is most commonly dominated or co-dominated by Banksia attenuata and/or B. menziesii. Other Banksia species that can dominate in the community are B. prionotes or B. ilicifolia. It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands; it is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau and can occur in other less common scenarios.	This community has been mapped as potentially occurring within the north west of the survey area. There is a lack of remnant vegetation within the survey area and therefore was not considered to be present within the Survey Area / Subject Site.
Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands, Swan Coastal Plain (floristic community type 3c as originally described in in Gibson et al. (1994))	CR / EN	The Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain ecological community is located on heavy soils of the eastern side of the Swan Coastal Plain between Bullsbrook, and Capel. Dominant species in the community are the trees Corymbia calophylla (marri), and occasionally Eucalyptus wandoo (wandoo); the shrubs Xanthorrhoea preissii, Acacia pulchella, Banksia dallanneyi, Gompholobium marginatum, and Hypocalymma angustifolium and the herbs Burchardia congesta, Cyathochaeta avenacea and Neurachne alopecuroidea. The introduced species Briza maxima and Hypochaeris glabra are also common, but weed levels in most occurrences are generally quite low (Gibson et al 1994).	Not present within the survey area
Dense shrublands on clay flats (floristic community type 9 as originally described in Gibson et al. (1994))	CR / EN	This vegetation community type is shrublands or low open woodlands on clay flats that are inundated for long periods because it usually occurs very low in the landscape. Sedges are more apparent in this ecological community and include Chorizandra enodis, Cyathochaeta avenacea, Lepidosperma longitudinale and Meeboldina coangustata. Shrubs include Hakea varia and Melaleuca viminea and occasionally Xanthorrhoea preissii, X. drummondii and Kingia australis. This vegetation community type has a lower species richness and weed frequency than in the other clay pan community types, presumably because of the longer inundation times.	Not present within the survey area
Herb rich shrublands in clay pans (floristic community type 8 as originally described in Gibson et al. (1994))	VU / EN	This vegetation community type occurs in low lying flats with a clay impeding layer allowing seasonal inundation. This vegetation community type is dominated by one or more of the shrubs: Viminaria juncea, Melaleuca viminea, M. lateritia, Kunzea micrantha or K. recurva with occasional emergent of Eucalyptus wandoo. Species such as Hypocalymma angustifolium, Acacia lasiocarpa var. bracteolata long peduncle variant (G. J. Keighery 5026) (P1) and Verticordia huegelii occur at moderate frequencies. This vegetation community type has a high percentage of weeds and appears to be the clay pan vegetation community type that has the greatest disturbance (Threatened Species Scientific Committee (TSSC) 2012).	Not present within the survey area
Low lying Banksia attenuata woodlands or shrublands	P3 / EN	This type occurs sporadically between Gingin and Bunbury, and is largely restricted to the Bassendean system. The type tends to occupy lower lying wetter sites and is variously dominated by Melaleuca preissiana, Banksia attenuata, B. menziesii, Regelia ciliata, Eucalyptus marginata or Corymbia calophylla. Structurally, this community type may be either a woodland or occasionally shrubland.	Not present within the survey area
Quindalup Eucalyptus gomphocephala and/or Agonis flexuosa woodlands	P3 / -	This community is dominated by either Tuart or Agonis flexuosa. The presence of Hibbertia cuneiformis, Geranium retrorsum and Dichondra repens differentiate this group from other Quindalup community types. The type is found from the Leschenault Peninsular south to Busselton.	Not present within the survey area
Southern Eucalyptus gomphocephala-Agonis flexuosa woodlands	P3	Woodlands of Eucalyptus gomphocephala - Agonis flexuosa south of Woodman Point. Recorded from the Karrakatta, Cottesloe and Vasse units. Dominants other than tuart were occasionally recorded, including Corymbia calophylla at Paganoni block and Eucalyptus decipiens at Kemerton. Occasionally dominants other than tuarts were recorded (Corymbia calophylla and Eucalyptus decipiens) however tuarts are emergent nearby. Banksias found in this community include Banksia attenuata, B. grandis and B. littoralis. Tuart formed the overstorey nearby however.	Not present within the survey area
Subtropical and Temperate Coastal Saltmarsh	P3 / VU	Consists of the assemblage of plants, animals and micro-organisms associated with saltmarsh in coastal regions of sub-tropical and temperate Australia (south of 23oS latitude). The habitat is coastal areas under tidal influence. In southern latitudes saltmarsh are the dominant habitat in the intertidal zone and often occur in association with estuaries. It is typically restricted to the upper intertidal environment, generally between the elevation of the mean high tide, and the mean spring tide. The community consists mainly of salt-tolerant vegetation (halophytes) including: grasses, herbs, reeds, sedges and shrubs. Succulent herbs and grasses generally dominate and vegetation is generally <0.5m tall with the exception of some reeds and sedges. Many species of non-vascular plants are also found in saltmarsh, including epiphytic algae, diatoms and cyanobacterial mats. Saltmarsh consists of many vascular plant species but is dominated by relatively few families. There is also typically a high degree of endemism at the species level. The two most widely represented coastal saltmarsh plant families are the Chenopodiaceae and Poaceae. Four structural saltmarsh forms are currently recognised based on dominance of a particular vegetation type: • dominance by succulent shrubs (e.g. Tecticornia). • dominance by grasses (e.g. Sporobolus virginicus). • dominance by sedges and grasses (e.g. Juncus kraussii, Gahnia trifida). • dominance by herbs (e.g. low-growing creeping plants such as Wilsonia backhousei, Samolus repens, Schoenus nitens).	Not present within the survey area
Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain	P3 / CR	Mostly confined to Quindalup Dunes and Spearwood Dunes from Jurien Bay to the Sabina River, with outliers along some rivers. Tuart is the key dominant canopy species however Tuart communities comprise a variety of flora and fauna assemblages. Flora commonly occurring with Tuart include Peppermint (Agonis flexuosa), Banksia attenuata, Banksia grandis, Allocasuarina fraseriana, Xylomelum occidentale, Macrozamia riedlei, Xanthorrhoea preissii, Spyridium globulosum, Templetonia retusa and Diplolaena dampieri. Threats: Land clearing, weed invasion, grazing, disease, altered fire regimes, hydrological change.	Not present within the survey area

Table A6: Risk assessment and survey outcomes for potential Threatened and Priority fauna within 10km of the survey area. Species are presented alphabetised under their relevant class.
Note: N = No, Y = Yes, P = Potential, L = Low, M = Medium, H = High

Habitat information taken from publicly available resources such as: DSEWPaC (2011) Survey guidelines for Australia's threatened mammals; DEWHA (2010) Survey guidelines for Australia's threatened birds; SPRAT profiles and species-specific recovery plans.

Class	Species	Common Name	Status WA / EPBC	Survey Method / Habitat description	Habitat Present	Likelihood of Detection of Species if present	Comment
Bird	Actitis hypoleucos	Common Sandpiper	IA / MI	Species is almost entirely coastal.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Anous stolidus	Common Noddy		Usually occurs on or near islands, on rocky islets and stacks with precipitous cliffs, or on shoals or cays of coral or sand. When not at the nest, individuals will remain close to the nest, foraging in the surrounding waters.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Anous tenuirostris melanops	Australian Lesser Noddy	VU	Marine Species.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Apus pacificus	Fork-tailed Swift	IA / MI	Survey areas of any potential habitat. Mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh (Higgins 1999). Almost exclusively aerial, flying from less than 1 m to at least 300 m above ground over inland plains but sometimes above foothills or in coastal areas.	Y	M	Species not observed during survey period.
Bird	Ardenna carneipes	Flesh-footed Shearwater	VU & IA / MI	Species prefers coastal areas and offshore islands.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Arenaria interpres	Ruddy Turnstone	IA / MI	Species prefers coastal areas and offshore islands.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Botaurus poiciloptilus	Australasian Bittern	EN / EN	Survey for birds in suitable habitat. Found in beds of tall rush mixed with, or near, short fine sedge or open pools. The species also occurs around swamps, lakes, pools, rivers and channels fringed with lignum (Muehlenbeckia sp.), canegrass (Eragrostis sp.) or other dense vegetation (Marchant & Higgins 1990).	N	M	No suitable habitat. Species not recorded during survey.
Bird	Calidris acuminata	Sharp-tailed Sandpiper	IA / MI	Assessment of habitat suitability for muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Calidris canutus	red knot	EN & IA / EN & MI	Species is almost entirely coastal. Red Knots gather in large flocks on the coast in sandy estuaries with tidal mudflats.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Calidris ferruginea	Curlew Sandpiper	CR & IA / CR & MI	Species is almost entirely coastal. Found on intertidal mudflats of estuaries, lagoons, mangroves, as well as beaches, rocky shores and around lakes, dams and floodwaters.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Calidris melanotos	Pectoral Sandpiper	IA / MI	Assessment of habitat suitability - shallow fresh to saline wetlands.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Calidris ruficollis	Red-necked Stint	IA / MI	Assessment of habitat suitability. Mostly coastal areas, including sheltered inlets, bays, lagoons and estuaries with intertidal mudflats; ephemeral or permanent shallow wetlands near the coast or inland, and sometimes flooded paddocks or damp grasslands (Higgins & Davies 1996).	N	M	No suitable habitat. Species not recorded during survey.
Bird	Calidris tenuirostris	Great Knot	CR & IA / CR & MI	Assessment of habitat suitability; inhabit intertidal mudflats and sandflats in sheltered coasts, including bays harbours and estuaries.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Calyptorhynchus banksii naso	forest red-tailed black cockatoo	VU / VU	Sightings and calls to identify potential breeding and roosting trees. Breeding tree survey and identification of suitable tree species within the survey area with a diameter at breast height (DBH) of over 50cm; Survey for presence and extent of foraging habitat (proteaceous heath/woodland, eucalypt woodlands or forest) and search for evidence of foraging such as chewed nuts.	Y	H	No individuals were observed during the survey perios (no calls or sightings). There was minor feed evidence observed in Collie River fringing vegetation but was not significant.
Bird	Calyptorhynchus baudinii	Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo	EN / EN	Sightings and calls to identify potential breeding and roosting trees. Breeding tree survey and identification of suitable tree species within the survey area with a diameter at breast height (DBH) of over 50cm; Survey for presence and extent of foraging habitat (proteaceous heath/woodland, eucalypt woodlands or forest) and search for evidence of foraging such as chewed nuts.	Y	H	Species was not observed during the survey period. No chewed nuts observed.
Bird	Calyptorhynchus latirostris	Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo	EN / EN	Sightings and calls to identify potential breeding and roosting trees. Breeding tree survey and identification of suitable tree species within the survey area with a diameter at breast height (DBH) of over 50cm; Survey for presence and extent of foraging habitat (proteaceous heath/woodland, eucalypt woodlands or forest) and search for evidence of foraging such as chewed nuts.	Y	H	Species was not observed during the survey period. No chewed nuts observed.
Bird	Charadrius leschenaultii	Greater Sand Plover	VU & IA / VU & MI	Species is almost entirely coastal, inhabiting littoral and estuarine habitats. Mainly occur on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons (Stewart et al. 2007). Seldom occur at shallow freshwater wetlands (Storr 1977).	N	M	No suitable habitat. Species not recorded during survey.
Bird	Charadrius mongolus	Lesser Sand Plover	EN & IA / EN & MI	Species prefers coastal areas and offshore islands.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Diomedea amsterdamensis	Amsterdam Albatross	EN	Marine, pelagic seabird. It nests in open patchy vegetation (among tussocks, ferns or shrubs) near exposed ridges or hillocks (Weimerskirch et al. 1985). It sleeps and rests on ocean waters when not breeding (Marchant & Higgins 1990).	N	M	No suitable habitat. Species not recorded during survey.

Table A6 continued.

Class	Species	Common Name	Status WA / EPBC	Survey Method / Habitat description	Habitat Present	Likelihood of Detection of Species if present	Comment
Bird	Diomedea dabbenena	Tristan Albatross	CR & IA / EN & MI	Marine, pelagic seabird that sleeps and rests on ocena waters when not breeding.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Diomedea epomophora	Southern Royal Albatross	VU & IA / VU & MI	Marine, pelagic seabird that sleeps and rests on ocena waters when not breeding.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Diomedea exulans	Wandering Albatross	VU & IA / VU & MI	Marine, pelagic seabird that sleeps and rests on ocena waters when not breeding.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Diomedea sanfordi	Northern Royal Albatross	EN & IA / EN & MI	Marine, pelagic and aerial. Habitat includes subantarctic, subtropical, and occasionally Antarctic waters.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Falco peregrinus	Peregrine Falcon	OS	Survey of potential habitat; almost exclusively aerial, flying above vegetation whilst hunting.	Y	M	Species not observed during survey period.
Bird	Hydroprogne caspia	Caspian Tern	IA / MI	Species prefers coastal areas and offshore islands.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Leipoa ocellata	malleefowl	VU / VU	Assessment of habitat suitability. In suitable habitat area searches for active mounds, tracks and sightings.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Limicola falcinellus	Broad-billed Sandpiper	IA / MI	Assessment of habitat suitability. Prefers sheltered parts of the coast, favouring estuarine mudflats but also occasionally occur on saltmarshes, shallow freshwater lagoons, saltworks and sewage farms, and in areas with large soft intertidal mudflats, which may have shell or sandbanks nearby.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Limosa lapponica	Bar-tailed Godwit	IA & VU / MI & VU	Survey for birds in suitable habitat; inhabit estuarine mudflats, beaches and mangroves.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Limosa limosa	Black-tailed Godwit	IA / MI	Species prefers coastal areas.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Macronectes giganteus	Southern Giant-Petrel	IA / EN & MI	Marine; Antarctic to subtropical waters.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Macronectes halli	Northern Giant Petrel	IA / MI	Marine, oceanic; mainly in subantarctic waters.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Motacilla cinerea	Grey Wagtail	IA / MI	Assessment of habitat suitability. Species has a strong association with water (wetlands, water courses banks of lakes and marshes, artificial wetlands).	Y	M	Species not observed during survey period.
Bird	Numenius madagascariensis	Eastern Curlew	CR & IA / CR & MI	Species prefers coastal areas and offshore islands.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Numenius phaeopus	Whimbrel	IA / MI	Species prefers coastal areas.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Oxyura australis	Blue-billed Duck	P4 / -	Assessment for suitable habitat. Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover.	N	M	Although the Collie River is a permanent waterbody there is very little aquatic vegetation / dense cover. Unlikely the species is utilising the area.
Bird	Pachyptila turtur subantarctica	Fairy Prion	VU	Marine; found mostly in temperate and subantarctic seas. Breeds on islands and rock stacks; burrowing in soil or using crevices and caves in cliffs or rock falls; can also nest in scrub, herbland, tussock or pasture.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Pandion cristatus	Osprey, Eastern Osprey	IA / MI	Species prefers coastal areas and offshore islands.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Plegadis falcinellus	Glossy Ibis	IA / MI	Survey for birds in suitable habitat; requires shallow water and mudflats, is found in well-vegetated wetlands, floodplains, mangroves and ricefields.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Pluvialis fulva	Pacific Golden Plover	IA / MI	Search for suitable habitat; coastal habitats, occasionally fresh, brackish or saline wetlands or claypans especially with muddy margins and often with submerged vegetation or short emergent grass. Other terrestrial habitats include short grass in paddocks, or ploughed or recently burnt areas (Marchant & Higgins 1993).	N	M	No suitable habitat. Species not recorded during survey.
Bird	Pluvialis squatarola	Grey Plover	IA / MI	Assessment of habitat suitability; sheltered embayments, estuaries and lagoons with mudflats and sandflats; terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes (Marchant & Higgins 1993).	N	M	No suitable habitat. Species not recorded during survey.
Bird	Rostratula australis	Australian Painted Snipe	EN	Assessment of habitat suitability. Shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or canegrass or sometimes tea-tree (Melaleuca). The Australian Painted Snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (Marchant & Higgins 1993).	N	M	Although the Collie River is a permanent waterbody there is very little riparian vegetation present providing preferred habitat. Unlikely the species is utilising the area.
Bird	Sternula nereis nereis	Australian Fairy Tern	VU / VU	Nests on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The subspecies has been found in embayments of a variety of habitats including offshore, estuarine or lacustrine (lake) islands, wetlands and mainland coastline (Higgins & Davies 1996; Lindsey 1986a). The bird roosts on beaches at night (Higgins & Davies 1996).	N		No suitable habitat. Species not recorded during survey.
Bird	Thalassarche cauta cauta	Shy Albatross	VU & IA / VU & MI	Marine species. Breeds on rock islands.	N	M	No suitable habitat. Species not recorded during survey.

Table A6 continued.

Class	Species	Common Name	Status WA / EPBC	Survey Method / Habitat description	Habitat Present	Likelihood of Detection of Species if present	Comment
Bird	Thalassarche cauta steadi	White-capped Albatross	VU & IA / VU & MI	Marine species and occurs in subantarctic and subtropical waters.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Thalassarche impavida	Campbell Albatross	VU & IA / VU & MI	Marine sea bird inhabiting sub-Antarctic and subtropical waters from pelagic to shelf-break water habitats.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Thalassarche melanophris	Black-browed Albatross	EN & IA / VU & MI	Marine species that inhabits Antarctic, subantarctic and temperate waters and occasionally enters the tropics.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Thalasseus bergii	Crested Tern	IA / MI	Species prefers coastal areas and offshore islands.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Tringa glareola	Wood Sandpiper	IA / MI	Assessment of habitat suitability. Seen in small flocks or singly on inland shallow freshwater wetlands, often with other waders. They prefer ponds and pools with emergent reeds and grass, surrounded by tall plants or dead trees and fallen timber.	N	M	Although the Collie River is a permanent waterbody there is very little riparian vegetation present providing preferred habitat. Unlikely the species is utilising the area.
Bird	Tringa nebularia	Common Greenshank, greenshank	IA / MI	Survey for calling birds in suitable habitat consisting of dam and creek line area for birds.	N	M	No suitable habitat. Species not recorded during survey.
Bird	Tringa stagnatilis	Marsh Sandpiper, little greenshank	IA / MI	Assessment for suitable habitat. Preers permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks.	N	M	No suitable habitat. Species not recorded during survey.
Bivalvia	Westralunio carteri	Carter's Freshwater Mussel,	VU	Assessment of habitat suitability. Patchily distributed in sandy/muddy sediments of freshwater lakes, rivers and streams with greatest densities associated with woody debris and overhanging riparian vegetation near stream banks and edges of lakes/dams.	Y	M	If present in the adjacent Collie River likely to be marginal habitat.
Fish	Nannatherina balstoni	Balston's Pygmy Perch	VU / VU	Search for suitable habitat including acidic, tannin-stained freshwater pools, streams and lakes in peat flats within 30 km of the coast of south-west Western Australia. The species prefers shallow water, and is commonly associated with tall sedge thickets and inundated riparian vegetation (Allen et al. 2002; Morgan et al. 1998).	Y	H	Potential habitat within the Collie River adjacent to the survey area. Species has been previously surveyed in this stretch of the Collie River and the species was not found. https://rivers.dwer.wa.gov.au/species/nannatherina-balstoni/
Invertebrate	Idiosoma sigillatum	Swan Coastal Plain shield-backed trapdoor spider	P3	outside of known distribution.	N	L	No suitable habitat. Species not recorded during survey.
Mammal	Bettongia penicillata subsp. ogilbyi	Woylie, Brush-tailed Bettong	CR / EN	Assessment of habitat, diggings and nest sites under dense bushes. Preferred habitat ranges from forest to grassland, coastal and inland.	N	H	No suitable habitat. Species not recorded during survey.
Mammal	Dasyurus geoffroii	Chuditch	VU / VU	Assessment of habitat suitability. Searches for faecal material and den sites in wooded habitat. Logs must have a diameter > 30 cm and a hollow with 7–20 cm diameter and 1 m length (Dunlop and Morris 2012). Prefers Jarrah Eucalyptus marginata forest woodland or mallee shrubland specifically in moist, densely vegetated, steep-sloping forest and riparian vegetation.	N	M	No suitable habitat. Species not recorded during survey.
Mammal	Hydromys chrysogaster	Water-rat, Rakali	P4 / -	Assessment of habitat and evidence of feeding. Wide variety of freshwater habitats, from subalpine streams and other inland waterways to lakes, swamps, and farm dams.	Y	M	Species not observed during survey period. No signs of creek-bank burrows or signs of feeding.
Mammal	Phascogale tapoatafa wambenger	Brush-tailed Phascogale	CD / -	Assessment of habitat suitability, potential hollows and scratchings.	Y		Potential habitat within the vegetation fringing the Collie River.
Mammal	Pseudocheirus occidentalis	western ringtail possum, ngwayir	CR / VU	Assessment of habitat suitability, hollows, dreys and search for faecal material. Suitable habitat in the southern forests includes Jarrah, Marri or Karri dominated forests. South coast habitat includes coastal heath, Jarrah/Marri woodland and forest, Peppermint Tree woodland, myrtaceous heaths and shrublands, Bullich dominated riparian zones and Karri forest (DPaW 2014).	Y	M	Potential habitat within the vegetation fringing the Collie River. Tree scratchings observed during the survey were associated with Brushtial possum scats. No dreys were detected. Suitable habitat is mainly restricted to the vegetation fringing the Collie River.
Mammal	Setonix brachyurus	quokka	VU / VU	Assessment of habitat suitability, faecal pellets and runnels. Preferred habitat includes woodland, forest, coastal heath, thicket and riparian vegetation.	N	M	No suitable habitat. Species not recorded during survey.
Mammalia	Falsistrellus mackenziei	Western False Pipistrelle	P4 / -	Surveys for potential hollows in suitable habitat; Preferred habitat of live mainly in wet sclerophyll forests of Karri, Jarrah and Tuart eucalypts. Roost in hollows in old trees, branches and stumps, in colonies.	Y	M	Marginal habitat - some potential hollows throughout the mature eucalypts. Species not recorded during survey.
Petromyzontida	Geotria australis	Pouched Lamprey	P3 / -	Assessment of habitat suitability. Species is anadromous and requires estuaries and coastal waters connected to freshwater rivers and streams with slow flowing, fine sediment microhabitats where spawning and development of ammocoetes occurs.	Y	M	Possible habitat within the adjacent Collie River.

Appendix D

Conservation Status Definitions and Condition Scale

Table A7: Conservation code definitions for flora and fauna as listed as threatened or specially protected.

Threatened, Extinct and Specially Protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

Threat Category	Definition
Threatened - Critically endangered species (CR)	Facing an extremely high risk of extinction in the wild in the immediate future.
Threatened - Endangered species (EN)	Facing a very high risk of extinction in the wild in the near future.
Threatened - Vulnerable species (VU)	Facing a high risk of extinction in the wild in the medium-term future.
Threatened - Extinct (EX)	There is no reasonable doubt that the last member of the species has died.
Threatened – Extinct in the wild (EW)	Species is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form.
Specially protected species - Migratory species (MI)	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.
Specially protected species – Conservation Dependent (CD)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
Specially protected species – Other specially protected species (OS)	Fauna otherwise in need of special protection to ensure their conservation.

Table A8: Conservation code definitions for flora and fauna as listed as Priority.

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3.

Threat Category	Definition
Priority 1: Poorly-known species	Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g., agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation.
Priority 2: Poorly-known species	Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g., national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation.
Priority 3: Poorly-known species	Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat.

Priority 4: Rare, Near Threatened and other species in need of monitoring	(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Table A9: Conservation code definitions for ecological communities listed as threatened (TEC).

Threat Category	Definition
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

Table A10: Conservation code definitions for ecological communities listed as priority (PEC).

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community List under priorities 1, 2 and 3.

Threat Category	Definition
Priority One (P1)	Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100ha), and appear to be under immediate threat.
Priority Two (P2)	Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation.
Priority Three (P3)	(i)Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation; or (ii)communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years); or (iii)communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc.

Priority Four (P4)	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.
Priority Five (P5)	Conservation Dependent ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Table A11: Condition Rating Scale adapted from Keighery 1994) outlined in EPA (2016a).

Vegetation Condition Rating	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

Appendix E

Revegetation Management Plan & Implementation Schedule

Weed Management - Refer to Section 8 -Table 11																
Period Post Subdivision	Broadleaf weeds Kikuyu, water couch etc.	Blowfly Grass	Guildford Grass	Watsonia	Narrowleaf Cottonbush	Apple of Sodom	Blackberry	Inkweed	Common Fig	Olive	Spear Thistle	Nightshade	Bridal Creeper	Fiddle Dock	Oxalis sp.	Cotula sp.
Year round	100mL gyphosate (450g/L) in 10L of water.			100g 2,2-DPA plus 25mL wetting agent in 10L water. Start at upper river reaches. Dig isolated plants.	Manual removal year round	Mechanical removal year round		Uproot heavy infestations and cut remaining plants5cm below ground. Spraying is effective, 100mL Tordon 75-D in 10L water.	Hand remove seedlings	Hand pull or dig out seedlings and small plants ensuring removal of all roots. Monitor sites for seedling recruitment	Manual removal					
Year 1 Post subdivision Spring Sept-Nov	100mL gyphosate (450g/L) in 10L of water. Repeat every 8 weeks or when regrowth reaches 5cm tall.	10mL glyphosate in 10L water early spring.			Apply a mixture of 120L amitrole(250g/L) in 10L water and spray the bush until thoroughly wet. Or Triclopyr (600g/L) Garlon 600® I Cut stump 1L/30L biodiesel or diesel Foliar spray with glyphosate or triclopyr during Autumn and Spring.	Seedlings controlled with 4L/ha glyphosate(450 g/L) or Grazon®. For mature plants spray foliage and a 1m buffer area until just wet with 100mL Grazon plus 25mL Pulse® in 10L water				For mature plants cut to base and paint 50% glyphosate or apply 250 ml Access® in 15 L of diesel to base 50 cm of trunk (basal bark).	Manual removal or selective spray control 500mL/ha Lontrel in bushland					
Year 1 Post subdivision Summer Dec-Feb						Seedlings controlled with 4L/ha glyphosate(450 g/L) or Grazon®. For mature plants spray foliage and a 1m buffer area until just wet with 100mL Grazon plus 25mL Pulse® in 10L water	Three annual summer applications of 100mLGrazon plus 25mL of pulse in 10L of water, use 100mL Glyphosate in 10L of water in sensitive areas (i.e. creeklines).		Stem inject with 50% glyphosate and foliar spray regrowth with 10% glyphosate. For stems less than 30cm diametre apply 250 ml Access® in 15 L of diesel to basal 50 cm of trunk (basal bark).			Prevent seed set for several years. Hand remove plants before flowering and/or spray 20mL Starane in 10L water during the plant is growing in summer.				

Weed Management - Refer to Section 11 -Table 11																
Period Post Subdivision	Broadleaf weeds Kikuyu, water couch etc.	Blowfly Grass	Guildford Grass	Watsonia	Narrowleaf Cottonbush	Apple of Sodom	Blackberry	Inkweed	Common Fig	Olive	Spear Thistle	Nightshade	Bridal Creeper	Fiddle Dock	Oxalis sp.	Cotula sp.
Year round	100mL gyphosate (450g/L) in 10L of water.			100g 2,2-DPA plus 25mL wetting agent in 10L water. Start at upper river reaches. Dig isolated plants.	Manual removal year round	Mechanical removal year round		Uproot heavy infestations and cut remaining plants5cm below ground. Spraying is effective, 100mL Tordon 75-D in 10L water.	Hand remove seedlings	Hand pull or dig out seedlings and small plants ensuring removal of all roots. Monitor sites for seedling recruitment	Manual removal					
Year 1 Post subdivision Autumn Mar-May					Apply a mixture of 120L amitrole(250g/L) in 10L water and spray the bush until thoroughly wet. Or Triclopyr (600g/L) Garlon 600® I Cut stump 1L/30L biodiesel or diesel Foliar spray with glyphosate or triclopyr during Autumn and Spring.					For mature plants cut to base and paint 50% glyphosate or apply 250 ml Access® in 15 L of diesel to base 50 cm of trunk (basal bark).						
Year 1 Post subdivision Winter Jun-Aug		10mL glyphosate in 10L water late winter	Spot spray metsulfuron methyl 0.2 g/15 L + Pulse® or 2.5-5 g/ha + Pulse®.										Spray 0.2 g metsulfuron methyl + Pulse® in 15 L water (or 2.5 - 5g /ha + Pulse®). Best results achieved when flowering. Persistent removal of the tops for several years exhausts tuber. Remove vertical growth as this is where most seed is set.	Remove isolated plants by cutting their roots at least 20cm below ground level. Small infestations 0.5g chlorsulfuron(600g/kg) plus 100mL Tordon®75-D in 10L of water.	0.1g metsulfuron (600g/kg) or 0.2g chlorsulfuron(750g/kg) plus 25mL wetting agent in 10L water applied when the plants are actively growing. Repeat if regrowth appears.	Manually remove isolated plants. Apply a range of herbicides such as Lontrel® in winter before flowering.

Weed Management - Refer to Section 11 -Table 11															
Period Post Subdivision	Broadleaf weeds Kikuyu, water couch etc.	Blowfly Grass	Guildford Grass	Watsonia	Narrowleaf Cottonbush	Apple of Sodom	Blackberry	Inkweed	Common Fig	Olive	Spear Thistle	Nightshade	Bridal Creeper	Fiddle Dock	Oxalis sp.	Cotula sp.
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Year 2 Post subdivision Spring Sept-Nov	100mL gyphosate (450g/L) in 10L of water. Repeat every 8 weeks or when regrowth reaches 5cm tall.	10mL glyphosate in 10L water early spring.			Apply a mixture of 120L amitrole(250g/L) in 10L water and spray the bush until thoroughly wet. Or Triclopyr (600g/L) Garlon 600® I Cut stump 1L/30L biodiesel or diesel Foliar spray with glyphosate or triclopyr during Autumn and Spring.	Seedlings controlled with 4L/ha glyphosate(450 g/L) or Grazon®. For mature plants spray foliage and a 1m buffer area until just wet with 100mL Grazon plus 25mL Pulse® in 10L water				For mature plants cut to base and paint 50% glyphosate or apply 250 ml Access® in 15 L of diesel to base 50 cm of trunk (basal bark).	Manual removal or selective spray control 500mL/ha Lontrel in bushland					
Year 2 Post subdivision Summer Dec-Feb						Seedlings controlled with 4L/ha glyphosate(450 g/L) or Grazon®. For mature plants spray foliage and a 1m buffer area until just wet with 100mL Grazon plus 25mL Pulse® in 10L water	Three annual summer applications of 100mLGrazon plus 25mL of pulse in 10L of water, use 100mL Glyphosate in 10L of water in sensitive areas (i.e. creeklines).		Stem inject with 50% glyphosate and foliar spray regrowth with 10% glyphosate. For stems less than 30cm diametre apply 250 ml Access® in 15 L of diesel to basal 50 cm of trunk (basal bark).			Prevent seed set for several years. Hand remove plants before flowering and/or spray 20mL Starane in 10L water during the plant is growing in summer.				

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Year 2 Post subdivisionAutumn Mar-May					Apply a mixture of 120L amitrole(250g/L) in 10L water and spray the bush until thoroughly wet. Or Triclopyr (600g/L) Garlon 600® I Cut stump 1L/30L biodiesel or diesel Foliar spray with glyphosate or triclopyr during Autumn and Spring.					For mature plants cut to base and paint 50% glyphosate or apply 250 ml Access® in 15 L of diesel to base 50 cm of trunk (basal bark).						
Year 2 Post subdivision Winter Jun-Aug		10mL glyphosate in 10L water late winter	Spot spray metsulfuron methyl 0.2 g/15 L + Pulse® or 2.5-5 g/ha + Pulse®.										Spray 0.2 g metsulfuron methyl + Pulse® in 15 L water (or 2.5 - 5g /ha + Pulse®). Best results achieved when flowering. Persistent removal of the tops for several years exhausts tuber. Remove vertical growth as this is where most seed is set.	Remove isolated plants by cutting their roots at least 20cm below ground level. Small infestations 0.5g chlorsulfuron(600g/kg) plus 100mL Tordon®75-D in 10L of water.	0.1g metsulfuron(600g/kg) or 0.2g chlorsulfuron (750g/kg) plus 25mL wetting agent in 10L water applied when the plants are actively growing. Repeat if regrowth appears.	Manually remove isolated plants. Apply a range of herbicides such as Lontrel® in winter before flowering.

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Year 3 Post subdivision Spring Sept-Nov	100mL gyphosate (450g/L) in 10L of water. Repeat every 8 weeks or when regrowth reaches 5cm tall.	10mL glyphosate in 10L water early spring.			Apply a mixture of 120L amitrole(250g/L) in 10L water and spray the bush until thoroughly wet. Or Triclopyr (600g/L) Garlon 600® I Cut stump 1L/30L biodiesel or diesel Foliar spray with glyphosate or triclopyr during Autumn and Spring.	Seedlings controlled with 4L/ha glyphosate(450 g/L) or Grazon®. For mature plants spray foliage and a 1m buffer area until just wet with 100mL Grazon plus 25mL Pulse® in 10L water				For mature plants cut to base and paint 50% glyphosate or apply 250 ml Access® in 15 L of diesel to base 50 cm of trunk (basal bark).	Manual removal or selective spray control 500mL/ha Lontrel in bushland					
Year 3 Post subdivision Summer Dec-Feb						Seedlings controlled with 4L/ha glyphosate(450 g/L) or Grazon®. For mature plants spray foliage and a 1m buffer area until just wet with 100mL Grazon plus 25mL Pulse® in 10L water	Three annual summer applications of 100mLGrazon plus 25mL of pulse in 10L of water, use 100mL Glyphosate in 10L of water in sensitive areas (i.e. creeklines).		Stem inject with 50% glyphosate and foliar spray regrowth with 10% glyphosate. For stems less than 30cm diametre apply 250 ml Access® in 15 L of diesel to basal 50 cm of trunk (basal bark).			Prevent seed set for several years. Hand remove plants before flowering and/or spray 20mL Starane in 10L water during the plant is growing in summer.				

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Year 3 Post subdivision Autumn Mar-May					Apply a mixture of 120L amitrole(250g/L) in 10L water and spray the bush until thoroughly wet. Or Triclopyr (600g/L) Garlon 600® I Cut stump 1L/30L biodiesel or diesel Foliar spray with glyphosate or triclopyr during Autumn and Spring.					For mature plants cut to base and paint 50% glyphosate or apply 250 ml Access® in 15 L of diesel to base 50 cm of trunk (basal bark).						
Year 3 Post subdivision Winter Jun-Aug		10mL glyphosate in 10L water late winter	Spot spray metsulfuron methyl 0.2 g/15 L + Pulse® or 2.5-5 g/ha + Pulse®.										Spray 0.2 g metsulfuron methyl + Pulse® in 15 L water (or 2.5 - 5g /ha + Pulse®). Best results achieved when flowering. Persistent removal of the tops for several years exhausts tuber. Remove vertical growth as this is where most seed is set.	Remove isolated plants by cutting their roots at least 20cm below ground level. Small infestations 0.5g chlorsulfuron(600g/kg) plus 100mL Tordon®75-D in 10L of water.	0.1g metsulfuron(600g/kg) or 0.2g chlorsulfuron (750g/kg) plus 25mL wetting agent in 10L water applied when the plants are actively growing. Repeat if regrowth appears.	Manually remove isolated plants. Apply a range of herbicides such as Lontrel® in winter before flowering.

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Year 4 Post subdivision Spring Sept-Nov	100mL gyphosate (450g/L) in 10L of water. Repeat every 8 weeks or when regrowth reaches 5cm tall.	10mL glyphosate in 10L water early spring.			Apply a mixture of 120L amitrole(250g/L) in 10L water and spray the bush until thoroughly wet. Or Triclopyr (600g/L) Garlon 600® I Cut stump 1L/30L biodiesel or diesel Foliar spray with glyphosate or triclopyr during Autumn and Spring.	Seedlings controlled with 4L/ha glyphosate(450 g/L) or Grazon®. For mature plants spray foliage and a 1m buffer area until just wet with 100mL Grazon plus 25mL Pulse® in 10L water				For mature plants cut to base and paint 50% glyphosate or apply 250 ml Access® in 15 L of diesel to base 50 cm of trunk (basal bark).	Manual removal or selective spray control 500mL/ha Lontrel in bushland					
Year 4 Post subdivision Summer Dec-Feb						Seedlings controlled with 4L/ha glyphosate(450 g/L) or Grazon®. For mature plants spray foliage and a 1m buffer area until just wet with 100mL Grazon plus 25mL Pulse® in 10L water	Three annual summer applications of 100mLGrazon plus 25mL of pulse in 10L of water, use 100mL Glyphosate in 10L of water in sensitive areas (i.e. creeklines).		Stem inject with 50% glyphosate and foliar spray regrowth with 10% glyphosate. For stems less than 30cm diametre apply 250 ml Access® in 15 L of diesel to basal 50 cm of trunk (basal bark).			Prevent seed set for several years. Hand remove plants before flowering and/or spray 20mL Starane in 10L water during the plant is growing in summer.				

Weed Management - Refer to Section 11 -Table 11																
Period Post Subdivision	Broadleaf weeds Kikuyu, water couch etc.	Blowfly Grass	Guildford Grass	Watsonia	Narrowleaf Cottonbush	Apple of Sodom	Blackberry	Inkweed	Common Fig	Olive	Spear Thistle	Nightshade	Bridal Creeper	Fiddle Dock	Oxalis sp.	Cotula sp.
Year round	100mL gyphosate (450g/L) in 10L of water.			100g 2,2-DPA plus 25mL wetting agent in 10L water. Start at upper river reaches. Dig isolated plants.	Manual removal year round	Mechanical removal year round		Uproot heavy infestations and cut remaining plants5cm below ground. Spraying is effective, 100mL Tordon 75-D in 10L water.	Hand remove seedlings	Hand pull or dig out seedlings and small plants ensuring removal of all roots. Monitor sites for seedling recruitment	Manual removal					
Year 4 Post subdivision Autumn Mar-May					Apply a mixture of 120L amitrole(250g/L) in 10L water and spray the bush until thoroughly wet. Or Triclopyr (600g/L) Garlon 600® I Cut stump 1L/30L biodiesel or diesel Foliar spray with glyphosate or triclopyr during Autumn and Spring.					For mature plants cut to base and paint 50% glyphosate or apply 250 ml Access® in 15 L of diesel to base 50 cm of trunk (basal bark).						
Year 4 Post subdivision Winter Jun-Aug		10mL glyphosate in 10L water late winter	Spot spray metsulfuron methyl 0.2 g/15 L + Pulse® or 2.5-5 g/ha + Pulse®.										Spray 0.2 g metsulfuron methyl + Pulse® in 15 L water (or 2.5 - 5g /ha + Pulse®). Best results achieved when flowering. Persistent removal of the tops for several years exhausts tuber. Remove vertical growth as this is where most seed is set.on removing vertical growth as this is where most seed is set.	Remove isolated plants by cutting their roots at least 20cm below ground level. Small infestations 0.5g chlorsulfuron(600g/kg) plus 100mL Tordon®75-D in 10L of water.	0.1g metsulfuron(600g/kg) or 0.2g chlorsulfuron (750g/kg) plus 25mL wetting agent in 10L water applied when the plants are actively growing. Repeat if regrowth appears.	Manually remove isolated plants. Apply a range of herbicides such as Lontrel® in winter before flowering.

Period	Revegetation	Fencing	Water Quality, nutrient and Stormwater Management
Area	All areas	All areas	All wetlands
Year round	Site inspections to monitor revegetation success rates. Inspecting erosion control areas and remediating as required.	Inspection of fencing and assess effectiveness and identify any mitigation measures needed.	12 monthly checks: No unusual vegetation deaths; sludge or scum; WQ clean and clear; Inspections after extended periods of heavy (above average) rain.
Year 1 Post subdivision Spring Sept-Nov	Commence weed management Commence erosion control measurements		
Year 1 Post subdivision Summer Dec-Feb	Source seedling stock, appoint landscape architect to finalise landscaped /revegetation areas.	Repair / replace old fencing that has fallen down along the Collie River. Install new fencing around foreshore area along the eastern boundary.	
Year 1 Post subdivision Autumn Mar-May	Ripping 600mm and re-compacting to 200mm where required. Deep augering and pot holing, auger to 600mm compacting to 200mm where/if required		
Year 1 Post subdivision Winter Jun-Aug	Initial planting in revegetation areas.		Inspections during winter, observations WQ & erosion/scouring. Erosion control.
Year 2 Post subdivision Spring Sept-Nov	Site inspection to determine if there are any immediate losses as a result of transplant shock, weed competition, predation or weather-related impacts.		
Year 2 Post subdivision Summer Dec-Feb			
Year 2 Post subdivision Autumn Mar-May	Site inspection to determine mortality and survival rates over the first summer period		
Year 2 Post subdivision Winter Jun-Aug	Infill planting as required ordering of any further infill tube stock required.		Inspections during winter, observations WQ & erosion/scouring. Erosion control.
Year 3 Post subdivision Spring Sept-Nov	Site inspection to assess the long-term success of the revegetation operation and determine the need for further remedial works		
Year 3 Post subdivision Summer Dec-Feb			
Year 3 Post subdivision Autumn Mar-May	Site inspection to assess the long-term success of the revegetation operation and determine the need for further remedial works		
Year 3 Post subdivision Winter Jun-Aug	Infill planting as required, ordering of any further infill tube stock required. Erosion Control - ie sandbagging planting infill as required		Inspections during winter, observations WQ & erosion/scouring. Erosion control.
Year 4 Post subdivision Spring Sept-Nov	Site inspection to assess the long-term success of the revegetation operation and determine the need for further remedial works		
Year 4 Post subdivision Summer Dec-Feb			
Year 4 Post subdivision Autumn Mar-May			
Year 4 Post subdivision Winter Jun-Aug	Infill planting as required ordering of any further infill tube stock required.		Inspections during winter, observations WQ & erosion/scouring. Erosion control.
Completion Targets	• A 90% survival rate of the planted seedlings within the designated areas. Should this rate not be met, infill planting will be required to raise the surviving plant numbers above 90% of the initial planting density; • In the specified revegetation zones the target is less than 20% weed cover, and for all declared and priority weed species to be 0%; and • Stabilization of banks that have become eroded.		

Appendix E

NatureMap and EPBC Act PMST reports

APPENDIX 3

Bushfire Management Plan Coversheet

This Coversheet and accompanying Bushfire Management Plan has been prepared and issued by a person accredited by Fire Protection Association Australia under the Bushfire Planning and Design (BPAD) Accreditation Scheme.

Bushfire Management Plan and Site Details

Site Address / Plan Reference: Lots 1, 2, 3, 100, 121, 246, 314, 878 and 3315 Treendale Road		
Suburb: Roelands	**State:** WA	**P/code:** 6226
Local government area: Shire of Harvey		
Description of the planning proposal: Structure Plan Amendment		
BMP Plan / Reference Number: MSC0285	**Version:** 2.0	**Date of Issue:** 09/03/2023
Client / Business Name: Tecon Australian		

Reason for referral to DFES	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	☐	☒
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the BPC elements)?	☐	☒
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	☐	☒
Strategic planning proposal (including rezoning applications)	☐	☒
Minor development (in BAL-40 or BAL-FZ)	☐	☒
High risk land-use	☐	☒
Vulnerable land-use	☐	☒

If the development is a special development type as listed above, explain why the proposal is considered to be one of the above listed classifications (E.g. considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

Note: The decision maker (e.g. local government or the WAPC) should only refer the proposal to DFES for comment if one (or more) of the above answers are ticked "Yes".

BPAD Accredited Practitioner Details and Declaration

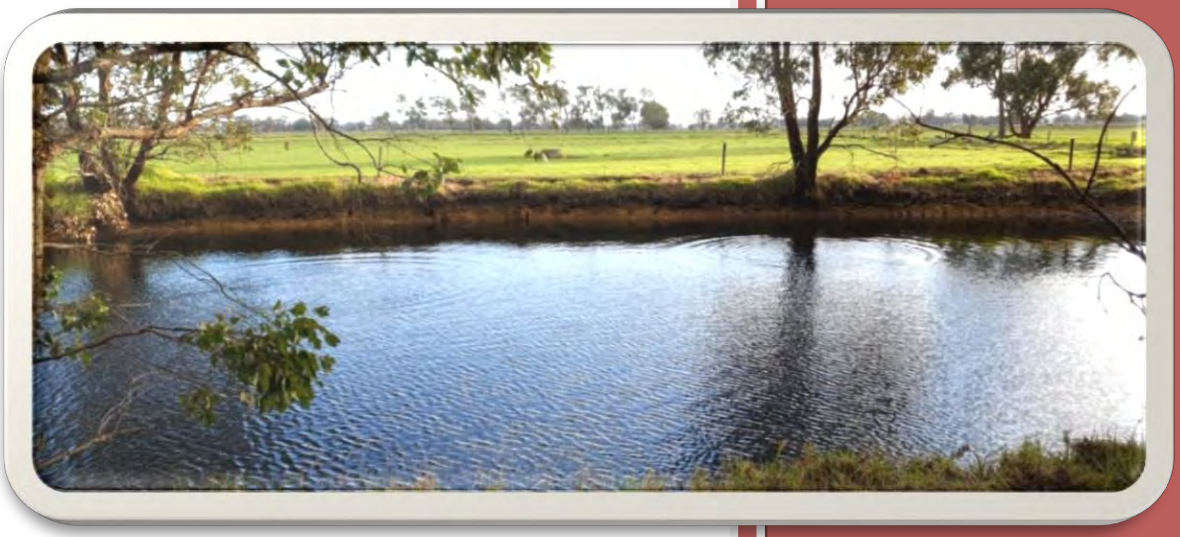
Name	Accreditation Level	Accreditation No.	Accreditation Expiry
Jason Benson	Level 2	BPAD 37893	31/07/2021
Company Bio Diverse Solutions		**Contact No.** 98421575	

I declare that the information provided within this bushfire management plan is to the best of my knowledge true and correct

Signature of Practitioner  **Date** 09/03/2023

Lot 1, 2, 3, 100, 121, 246, 314, 878 and 3315 Treendale Road Roelands WA 6226

Bushfire Management Plan



BIO DIVERSE SOLUTIONS

9 March 2023

Bio Diverse Solutions

DOCUMENT CONTROL

TITLE

Title: Bushfire Management Plan Treendale Structure Plan
Author (s): Jason Benson and Kathryn Kinnear
Reviewer (s): K. Kinnear
Job No.: MSC0285
Client: Tecon Australia

REVISION RECORD

Revision	Summary	Prepared by:	Reviewed By	Date
Draft Id	Internal QA Review	Jason Benson	Kathryn Kinnear	31/07/2020
Draft Id	Issued to client for review	Jason Benson	Kristy Richardson	31/07/2020
Final Id	Final Issue to client	Jason Benson	Kathryn Kinnear	8/10/2020
Final Id V2	Mapping and Report amendments in line with DFES Comments	Jason Benson	Kathryn Kinnear	9/03/2023

The recommendations and measures contained in this assessment report are based on the requirements of the Australian Standards 3959 – Building in Bushfire Prone Areas, WAPC SPP3.7, Guidelines for Planning in Bushfire Prone Areas (WAPC, 2017) and CSIRO's research into Bushfire behaviour. These are considered the minimum standards required to balance the protection of the proposed dwelling and occupants with the aesthetic and environmental conditions required by local, state and federal government authorities. They DO NOT guarantee that a building will not be destroyed or damaged by a bushfire. All surveys and forecasts, projections and recommendations made in this assessment report and associated with this proposed dwelling are made in good faith on the basis of the information available to the fire protection consultant at the time of assessment. The achievement of the level of implementation of fire precautions will depend amongst other things on actions of the landowner or occupiers of the land, over which the fire protection consultant has no control. Notwithstanding anything contained within, the fire consultant/s or local government authority will not, except as the law may require, be liable for any loss or other consequences (whether or not due to negligence of the fire consultant/s and the local government authority, their servants or agents) arising out of the services rendered by the fire consultant/s or local government authority.

BIO DIVERSE SOLUTIONS

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

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Executive Summary

Tecon Australian commissioned Bio Diverse Solutions (Bushfire Consultants) to prepare a Bushfire Management Plan to guide all future bushfire management measures for the amendment to the approved structure plan for Lots 1, 2, 3, 100, 121, 246, 314, 878 and 3315 Treendale Road, Roelands within the Shire of Harvey. The development site of approximately 309ha is partially located within a designated bushfire prone area (OBRM, 2021), see Figure 3 and requires the application of State Planning Policy No. 3.7: Planning in Bushfire Prone Areas (SPP 3.7).

The subject site was assessed as having internal areas of Forest Type A, Grassland Type G and Non-vegetated Areas. The subject site consists of 9 existing lots which are zoned General Farming and Intensive Farming under the Shire of Harvey Local Planning Scheme Zone No. 1. The plan is to amend the approved Treendale South Area 3B Structure Plan (February 1996) to comply with current regulations. The assessed bushfire risk is considered manageable and can be achieved by the identified stakeholders implemented bushfire management measures documented within this report.

The predominant vegetation within the subject site is Class G Grassland and it is expected that this vegetation can be managed in a low threat state to the extent that future dwelling will be able to achieve BAL-29 or lower.

The western section of Treendale Road will possibly be cut off and potentially closed as part of the Bunbury Outer Ring Road (BORR) project, this will create temporary cul-de-sacs that will be linked post construction of the BORR once confirmation of the status of the existing road network is confirmed. The development area also has access to Raymond Road which provides safe access to two different destinations.

The subject site is located adjacent to a reticulated water supply the nearest hydrant is located adjacent to the site on Treendale Road to the west of the development boundary. A reticulated water supply will be installed to meet the technical requirement established by the guidelines.

Table 1: Bushfire protection criteria applicable to the site

Element	Acceptable Solution	Applicable or not Yes/No	Meets Acceptable Solution
Element 1 – Location	A1.1 Development Location	Yes	Compliant - BAL 29 or lower can be applied to existing and future buildings.
Element 2 – Siting and Design	A2.1 Asset Protection Zone (APZ)	Yes	Compliant - Existing and future buildings have the ability to have an APZ of the required dimensions to achieve BAL-29 or lower.
Element 3 – Vehicular Access	A3.1 Two Access Routes	Yes	Compliant - Access to two different destinations is available.
	A3.2 Public Road	Yes	Compliant – The proposed road network will provide the site with save vehicle access.
	A3.3 Cul-de-sac	Yes	Compliant - Temporary
	A3.4 Battle axe	N/A	N/A
	A3.5 Private driveways	Yes	Compliant - Private driveways are or will be constructed to the required standard.
	A3.6 Emergency Access Way	Yes	Compliant – Possibly in the future
	A3.7 Fire Service Access Ways	N/A	N/A
	A3.8 Firebreaks	Yes	Compliant on parent lot, future lots will comply.
Element 4 – Water	A4.1 Reticulated areas	Yes	Compliant – In the future
	A4.2 Non-reticulated areas	N/A	N/A
	A4.3 Individual lots in non-reticulated areas	N/A	N/A

1 Proposal Details

Tecon Australian commissioned Bio Diverse Solutions (Bushfire Consultants) to prepare a Bushfire Management Plan to guide all future bushfire management measures for the amendment to the approved structure plan for Lots 1, 2, 3, 100, 121, 246, 314, 878 and 3315 Treendale Road, Roelands within the Shire of Harvey. This BMP has been prepared to assess the subject site to the current and endorsed Guidelines for Planning in Bushfire Prone Areas Vers 1.3 (WAPC, 2017) and State Planning Policy 3.7 (WAPC, 2015). The total development area is approximately 309ha (9 existing lots) and the amended structure plan will look to facilitate the development of 124 Rural Residential lots of 1ha in size or larger.

Such planning takes into consideration standards and requirements specified in various documents such as Australian Standard (AS) 3959-2018, Western Australian Planning Commission (WAPC) Guidelines for Planning in Bushfire Prone Areas Vers 1.3 (WAPC, 2017) and State Planning Policy 3.7 (WAPC, 2015). These policies, plans and guidelines have been developed by WAPC to ensure uniformity to planning in designated "Bushfire Prone Areas" and consideration of the relevant bushfire hazards when identifying or investigating land for future development.

1.1 Location

The subject site is described as Lots 1, 2, 3, 100, 121, 246, 314, 878 and 3315 Treendale Road, Roelands and is approximately 309ha in total size. The site located approximately 6km west of the Roelands. The location of the subject site is shown on Figure 1.

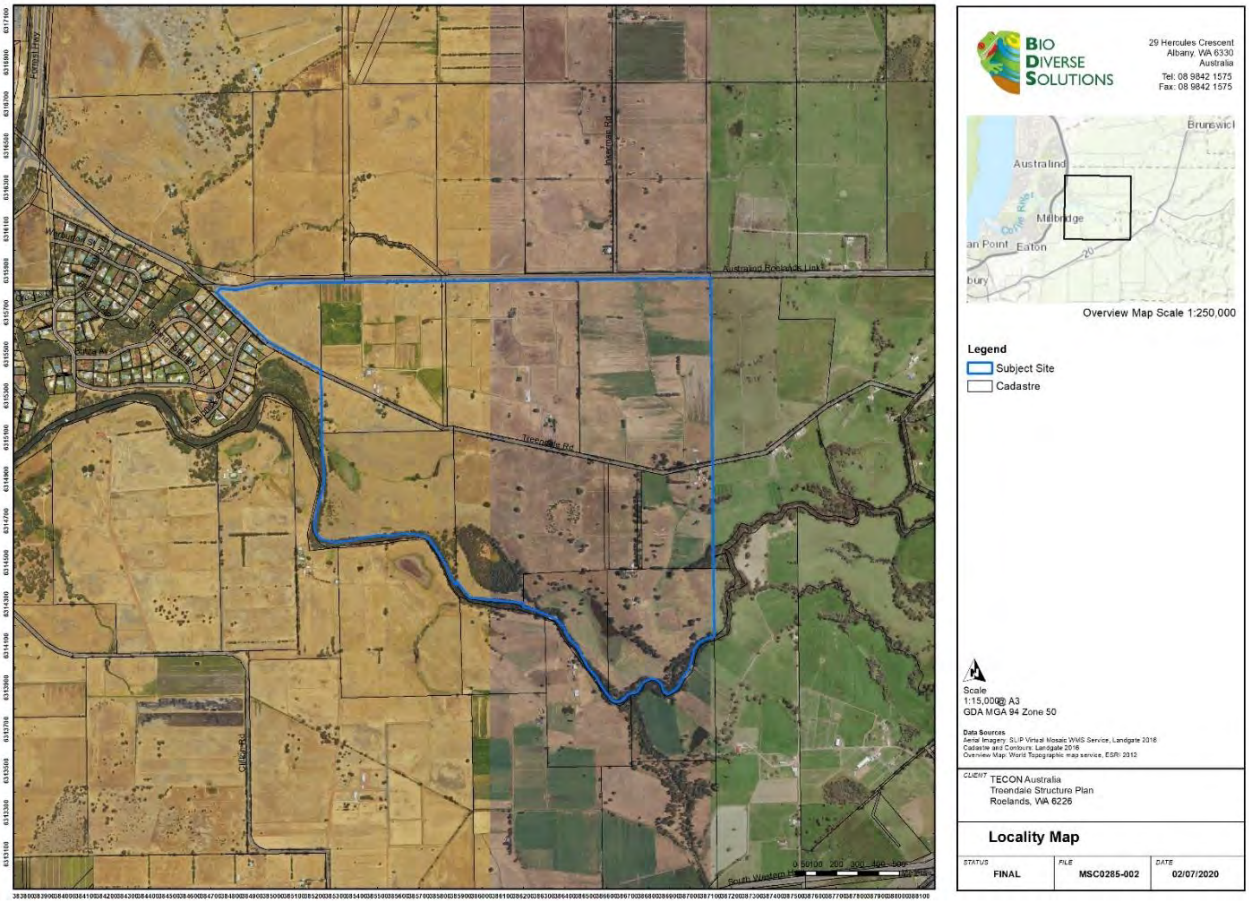

Figure 1: Location Plan

1.2 Development Proposal

The proposal is to amend the approved structure plan for Lots 1, 2, 3, 100, 121, 246, 314, 878 and 3315 Treendale Road, Roelands. The total development area is approximately 309ha (9 existing lots) and the amended structure plan will look to facilitate the development of 124 Rural Residential lots of 1ha in size or larger, refer to Table 2 below for existing lot sizes and Figure 2 Concept Plan for the lot layout and sizes.

Table 2: Existing and Proposed Lot Details.

Approximate Total Area (ha)		**~309**	
Existing Lots			
Lot	**Area (ha)**	**Lot**	**Area (ha)**
1	48.3793	**246**	13.0479
2	56.282	**314**	26.9585
3	16.1774	**878**	40.6484
100	12.3573	**3315**	54.0259
121	32.5598		

1.3 Planning background

The Landholdings are within the *1996 Treendale Structure Plan* (Policy Area 3B – 1996 Structure Plan) which was endorsed by the WAPC in February 1996 and applies to a number of properties between Raymond Road and the Collie River. The Landholdings have been designated under the 1996 Structure Plan for future rural residential development.

The Department of Planning, Lands and Heritage (the Department) has considered the status of the 1996 Structure Plan and has determined that the Plan has full legal effect as a document to be given due regard in any decision making.

In noting the status of the 1996 Structure Plan and the advice from DPLH that the 1996 structure plan has full legal affect there is still a need to amend the document to address the implications of the Bunbury Outer Ring Road (BORR) as well as comprehensively addressing environmental and engineering servicing considerations.

The Amended Structure Plan will provide the framework for the coordinated provision and arrangement of the land uses, subdivision and development. It will also inform the provision of a transport network, public open space, public utilities, development standards, community infrastructure and urban water management.

RAYMOND ROAD

INDICATIVE FUTURE WIDENING OF RAYMOND ROAD CONSISTENT WITH THE GREATER BUNBURY REGION SCHEME

SPECIAL RESIDENTIAL

TREENDALE ROAD

SUBJECT TO FUTURE ROAD CLOSURE OF PORTION OF TREENDALE ROAD

EMERGENCY ACCESS WAY

TREENDALE ROAD

OPEN SPACE

LEGEND

LOCAL SCHEME RESERVES

PUBLIC PURPOSE - NOISE BUND

ZONES

RURAL RESIDENTIAL

RESERVED ROADS

PRIMARY REGIONAL ROADS

OTHER

ACCESS ROAD

STRUCTURE PLAN BOUNDARY

CONCEPT PLAN BOUNDARY

EXISTING CADASTRE

DRAINAGE BASIN

TREENDALE POLICY AREA 3B
CONCEPT PLAN
STAGE ONE

Figure 2: Concept Plan

1:4000
At A1
0 50m 100 150 200 250 300 350 400

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NORTHERN TERRITORY

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1.4 Bushfire Prone Area

The publicly released Bushfire Prone Area Mapping (OBRM, 2021) shows the subject site is partially located within a Bushfire Prone Area (situated within 100m of >1 ha of bushfire prone vegetation). Refer to Figure 3, Bushfire Prone Area Mapping.

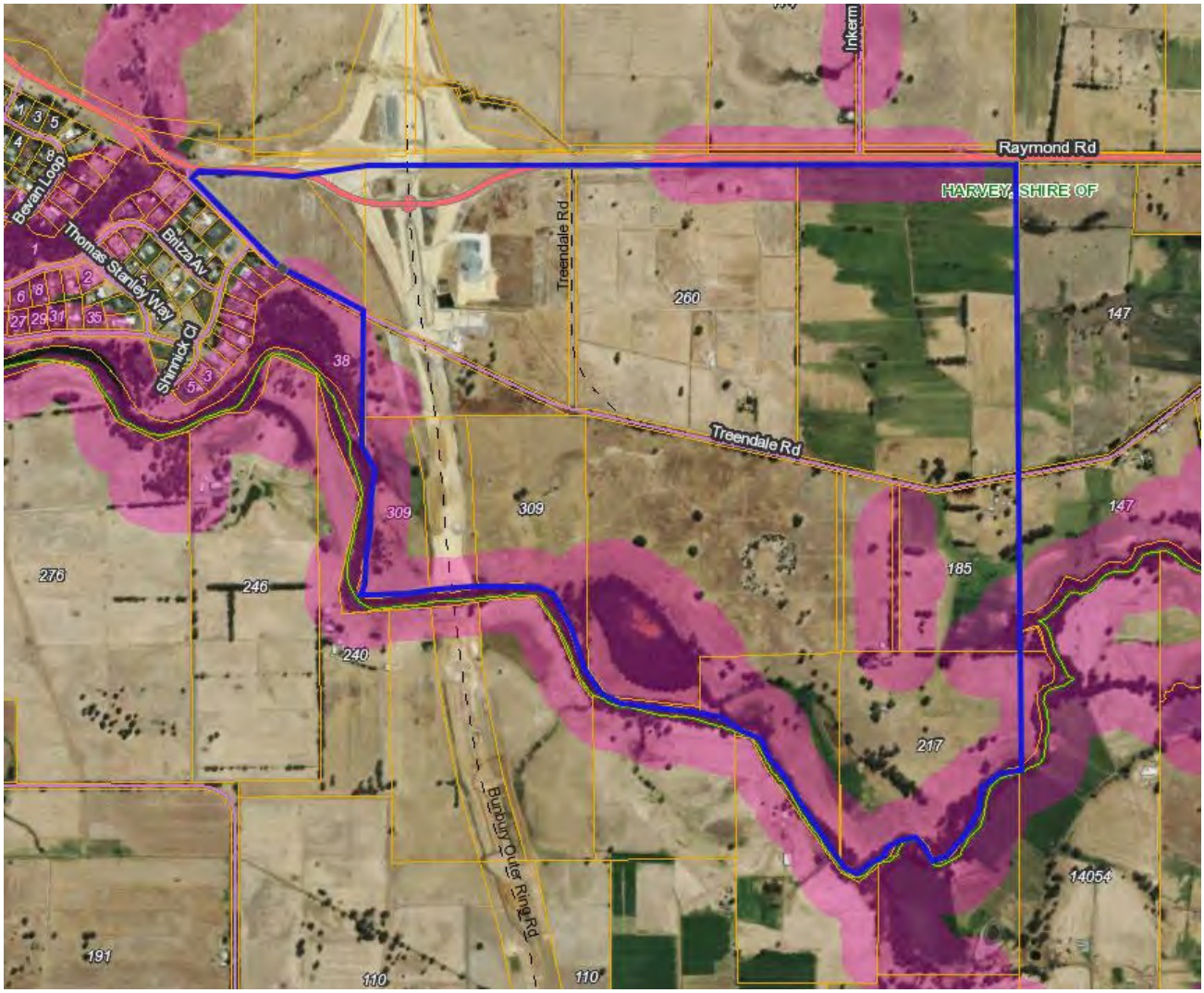


Figure 3: Bushfire Prone Area Mapping (OBRM, 2021)

1.5 Statutory Framework

This document has been prepared to support the amendment to the approved Treendale South Area 3B Structure Plan (February 1996) to comply with current regulations.

This document and the recommendations contained within are aligned to the following policy and guidelines:

- Planning and Development Act 2005;
- Planning and Development Regulations 2009;
- Planning and Development (Local Planning Scheme) Regulations 2015;
- State Planning Policy 3.7 Planning in Bushfire Prone Areas;
- Guidelines for Planning in Bushfire Prone Areas;
- Building Act 2011;
- Building Regulations 2012;
- Building code of Australia (National Construction Code);
- Fire and Emergency Services Act 1998.
- AS 3959-2018 “Construction of Buildings in Bushfire Prone Areas” current and endorsed standards;
- Bushfires Act 1954; and
- Shire of Harvey Annual Firebreak Order.

1.6 Suitably Qualified Bushfire Consultant

This BMP has been jointly prepared by Jason Benson and Kathryn Kinnear. Jason Benson has 8 years operational fire experience with the (formerly) DEC (between 2002-2012) and has the following accreditation in bushfire management:

- Heavy Duty Fire Appliance Operator;
- Wildfire Suppression 1 & 2;
- Prescribed Burning Operations;
- Fire and Incident Operations;
- Structural Modules – Hydrants and hoses, Introduction to Structural Fires, and Fire extinguishers; and
- Ground Controller.

Jason Benson is an accredited Level 2 Bushfire Practitioner (Accreditation No: BPAD37893) and has been an accredited Bushfire Consultant for 7 years. Jason is a suitably qualified Bushfire Practitioner to prepare this Bushfire Management Plan (BMP).

Kathryn Kinnear (nee White), has 10 years operational fire experience with the (formerly) DEC (1995-2005) and has the following accreditation in bushfire management:

- Incident Control Systems;
- Operations Officer;
- Prescribed Burning Operations;
- Fire and Incident Operations;
- Wildfire Suppression 1, 2 & 3;
- Structural Modules – Hydrants and hoses, Introduction to Structural Fires, and Fire extinguishers; and
- Ground Controller.

Kathryn Kinnear currently has the following tertiary Qualifications:

- BAS Technology Studies & Environmental Management;
- Diploma Business Studies; and
- Graduate Diploma in Environmental Management.

Kathryn Kinnear is an accredited Level 2 Bushfire Practitioner (Accreditation No: BPAD30794) with 29 years of bushfire management and planning experience. Bio Diverse Solutions are Silver Corporate Members of the

Fire Protection Australia Association and are suitably qualified Bushfire Practitioners to prepare this Bushfire Management Plan.

1.7 Objectives

The objectives of this BMP are to assess the present and future bushfire risks associated with the site and for the proposed amendment to the approved structure plan. The BMP aims to reduce the occurrence of, and minimise the impact of bushfires, thereby reducing the threat to life, property and the environment. It also aims to guide the structure plan design by assessing the site to the Bushfire Protection Criteria Acceptable Solutions as outlined in the Guidelines for Planning in Bushfire Prone Areas Vers 1.3 (WAPC, 2017).

The BMP objectives are to:

- Achieve consistency with objectives and policy measures of SPP 3.7 (WAPC, 2015);
- Classify the vegetation in accordance with the AS3959-2018
- Assess any building requirements to AS3959-2018 (current and endorsed standards) and BAL Construction;
- Assess the amended structure plan against the Bushfire Protection Criteria Acceptable Solutions as outlined in the Guidelines for Planning in Bushfire Prone Areas (WAPC, 2017);
- Understand and document the extent of the bushfire risk and hazards pertinent to the subject site;
- Prepare bushfire management measures within the subject site with due regard to life, property, infrastructure and the environment; and
- Nominate individuals and organisations responsible for fire management and associated works for implementation within the subject site in the subsequent planning stages.

2 Environmental Considerations

The subject site includes within its boundary five Geomorphic Wetlands, one of which is the Collie River which is situated along the southern boundary of the subject site. Three of the mapped wetlands are “Multiple Use” one is classed as “Resource Enhancement” and one is classed as “Conservation”. There is one Environmentally Sensitive Area (ESA) that extends within the subject site along the western boundary, this is associated with the Conservation wetland (UFI 1734).

Bio Diverse Solutions has prepared a Wetland Management Plan (WMP) for the subject site which is focused on the southern floodplain and wetland area in the south. As part of the preparation of the WMP a foreshore area within the south of the subject site and development exclusions zones in the east a small portion in the west have been developed. Within the proposed foreshore area revegetation of the three wetlands has been recommended, as well as the drainage line located south of Treendale Road in the south east of the subject site. These areas of revegetation once mature are expected to be classified as Forest Type A and have been included in the vegetation assessment for this BMP. Furthermore, there has been a 50m and 30m buffer applied to these areas and is assumed to unmanaged grassland.

The Priority 4 (P4) species *Eucalyptus rudis subsp. cratyantha* was observed within the southern floodplain area during the wetland site assessment by Bianca Theyer of Bio Diverse Solutions. It has also been previously been recorded throughout the subject site by 360 Environmental. These are likely to be able to be retained in the overall subdivision design.

2.1 Native vegetation – modification and clearing

A small area of vegetation (Plot 9 Forest) central to the site, is planned to removed/modified to a low threat state as part of this proposal. The area consists of paddock trees (predominantly melaleucas) with a grassy understorey, which could be parkland cleared to minimise the removal of trees, while also reducing the BAL rating for the surrounding lots.

2.2 Re-vegetation/Landscape Plans

There are areas of vegetation retention and wetland revegetation planned as part of this proposal which in the future will be ceded as Public Open Space, these areas occur in the south and south-west of the site within degraded areas. The aim is to rehabilitate degraded areas, reduce weed incursion and attract native fauna. The revegetation areas will consist of predominantly endemic Swan Coastal Plain species (trees, shrubs, sedges and rushes). A Landscape Concept Plan will be required at subdivision stage to guide the POS development. The revegetation areas have been considered in the future bushfire management of the development area and have been classified accordingly. It is expected that these areas will present as Forest Type A, see Figure 4 for revegetation extent. The BAL ratings emanating from these areas have been indicated on Figure 5 BAL Contour Plan.

There are wetland buffers planned as part of this proposal, no construction will take place within these buffers. See Figure 4 wetland buffer extent.

3 Bushfire Assessment Results

3.1 Assessment Inputs

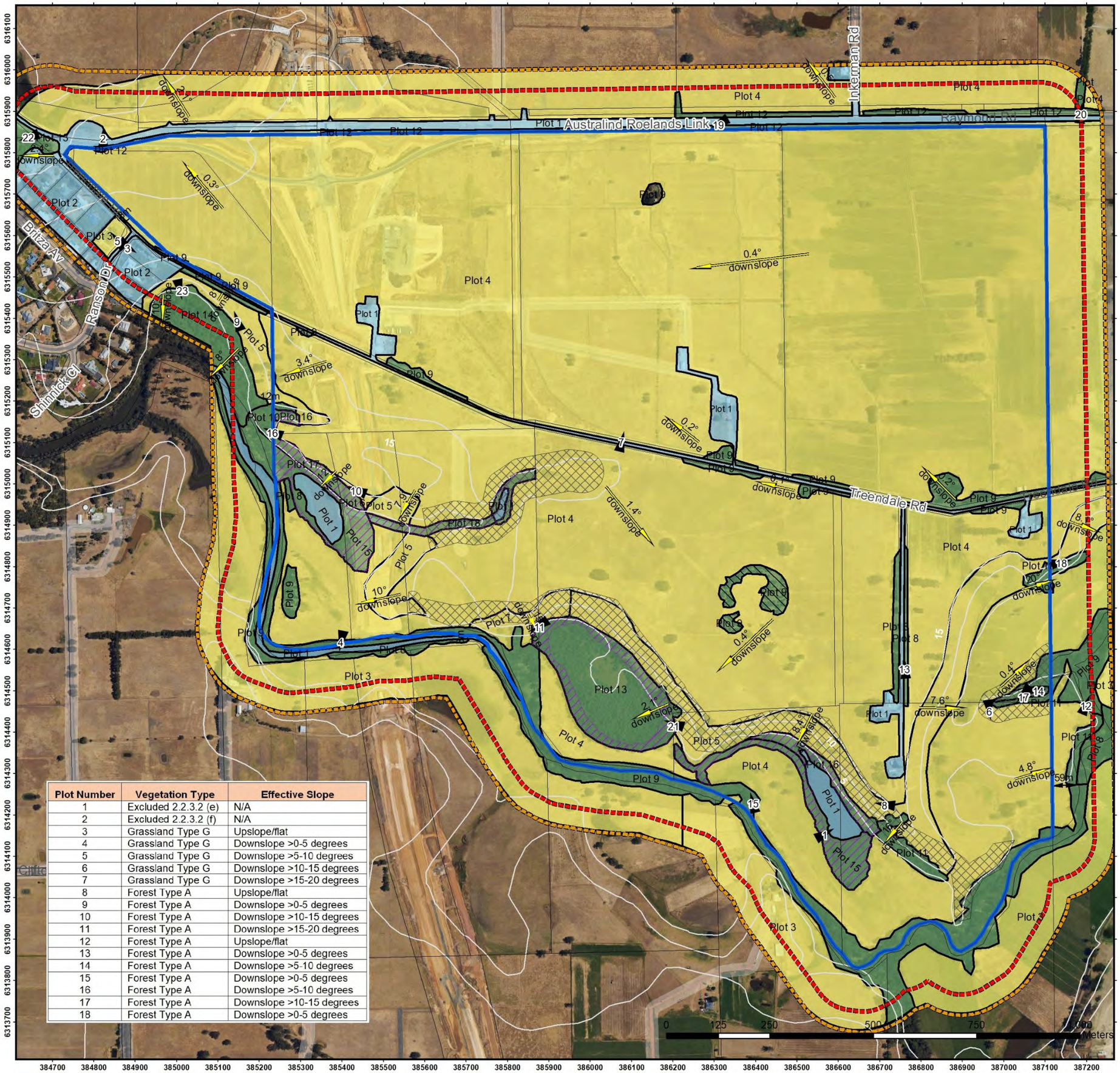
Bushfire Assessment inputs for the site has been calculated using the Method 1 procedure as outlined in AS3959-2018. This incorporates the following factors:

- WA adopted Fire Danger Index (FDI), being FDI 80;
- Vegetation Classes;
- Slope under classified vegetation; and
- Distance between proposed development site and classified vegetation.

A site inspection was undertaken on the 25th and 26th of June by Jason Benson to assess the current land use, topography/slope, vegetation and conditions of the site and its surroundings. Photographs of the Subject Site and surrounding areas were taken and have been presented in this report.

3.2 Vegetation classification AS3959

All vegetation within 150m of the site / proposed development was classified in accordance with Clause 2.3 and Exclusions as per Clause 2.2.3.2 of AS 3959-2018. Each plot is representative of the Vegetation Classification to AS3959-2018 Table 2.3 and shown on the Vegetation Classification Mapping (Figure 4). Full plot data report can be found in Appendix A of this document.



Plot Number	Vegetation Type	Effective Slope
1	Excluded 2.2.3.2 (e)	N/A
2	Excluded 2.2.3.2 (f)	N/A
3	Grassland Type G	Upslope/flat
4	Grassland Type G	Downslope >0-5 degrees
5	Grassland Type G	Downslope >5-10 degrees
6	Grassland Type G	Downslope >10-15 degrees
7	Grassland Type G	Downslope >15-20 degrees
8	Forest Type A	Upslope/flat
9	Forest Type A	Downslope >0-5 degrees
10	Forest Type A	Downslope >10-15 degrees
11	Forest Type A	Downslope >15-20 degrees
12	Forest Type A	Upslope/flat
13	Forest Type A	Downslope >0-5 degrees
14	Forest Type A	Downslope >5-10 degrees
15	Forest Type A	Downslope >0-5 degrees
16	Forest Type A	Downslope >5-10 degrees
17	Forest Type A	Downslope >10-15 degrees
18	Forest Type A	Downslope >0-5 degrees

This BAL Plan was prepared by:
Kathryn Kinnear, Bio Diverse Solutions
Accreditation No: BPAD30794
Jurisdiction: Level 2 - WA

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

BIO DIVERSE SOLUTIONS

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Albany, WA 6330
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Overview Map Scale 1:100,000

Legend

- Subject Site
- 100m Assessment Boundary
- 150m Assessment Boundary
- Cadastre
- 5m Contours
- Separation Distance
- Slope Degrees
- Photo Point
- Wetland Buffers
- Revegetation Extents (Refer to Wetland Management Plan)
- Future Low Fuel
- Vegetation/Plot Boundary

Vegetation

- Forest Type A
- Woodland Type B
- Grassland Type G
- Low fuel or non vegetated 2.2.3.2

Scale
1:9,000 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

CLIENT
Tecon Australia
Treendale Structure Plan, Treendale Road
Roelands, WA 6226

Figure 4: Vegetation Classes Mapping

BAL Assessor	*QA Check*	*Drawn by*
JB	**KK**	**SA**
STATUS	*FILE*	*DATE*
FINAL	**MSC0285-001**	**09/03/2023**

3.3 Fire Danger Index

The Western Australian adopted FDI is 80 as outlined in AS3959-2018 and endorsed by Australasian Fire and emergency Services Authorities Council. The FDI input for this project is also therefore 80.

3.4 Slope Under Classified Vegetation

Slope under classifiable vegetation (Effective Slope) was assessed in accordance with Section 2.2.5 of AS3959-2018. Table 2 below summarises the slopes assigned to each plot of classifiable vegetation for the BAL calculation.

Table 3: Effective slope allocation to classified vegetation

Plot number	Vegetation Type (Table 2.3)	Slope (Table 2.4.3)
1	Excluded 2.2.3.2 (e)	N/A
2	Excluded 2.2.3.2 (f)	N/A
3	Grassland Type G	Upslope/flat
4	Grassland Type G	Downslope >0-5 degrees
5	Grassland Type G	Downslope >5-10 degrees
6	Grassland Type G	Downslope >10-15 degrees
7	Grassland Type G	Downslope >15-20 degrees
8	Forest Type A	Upslope/flat
9	Forest Type A	Downslope >0-5 degrees
10	Forest Type A	Downslope >10-15 degrees
11	Forest Type A	Downslope >15-20 degrees
12	Forest Type A	Upslope/flat
13	Forest Type A	Downslope >0-5 degrees
14	Forest Type A	Downslope >5-10 degrees
15	Forest Type A	Downslope >0-5 degrees
16	Forest Type A	Downslope >5-10 degrees
17	Forest Type A	Downslope >10-15 degrees
18	Forest Type A	Downslope >0-5 degrees

Plots 1 and 2 are allocated exclusion Clauses 2.2.3.2 and therefore do not have an effective slope allocation. Plots 15, 16, 17 and 18 are revegetation plots and have been classified based on the expected future vegetation in its matured state.

3.5 Assessment Outputs

3.6 BAL Calculation AS3959 (BAL Contour Plan)

A Method 1 BAL calculation (in the form of BAL contours) has been completed to support the proposed structure plan amendment in accordance with AS3959-2018 methodology. The BAL rating gives an indication of the level of bushfire attack (i.e. the radiant heat flux) that may be received by proposed buildings and subsequently informs the standard of building construction required to increase building tolerance to potentially withstand such impacts in line with the assessed BAL.

The assessed BAL ratings for the development is depicted as BAL contours, as shown on Figure 5.

COMMENTS ON BAL CALCULATIONS/METHODOLOGY:

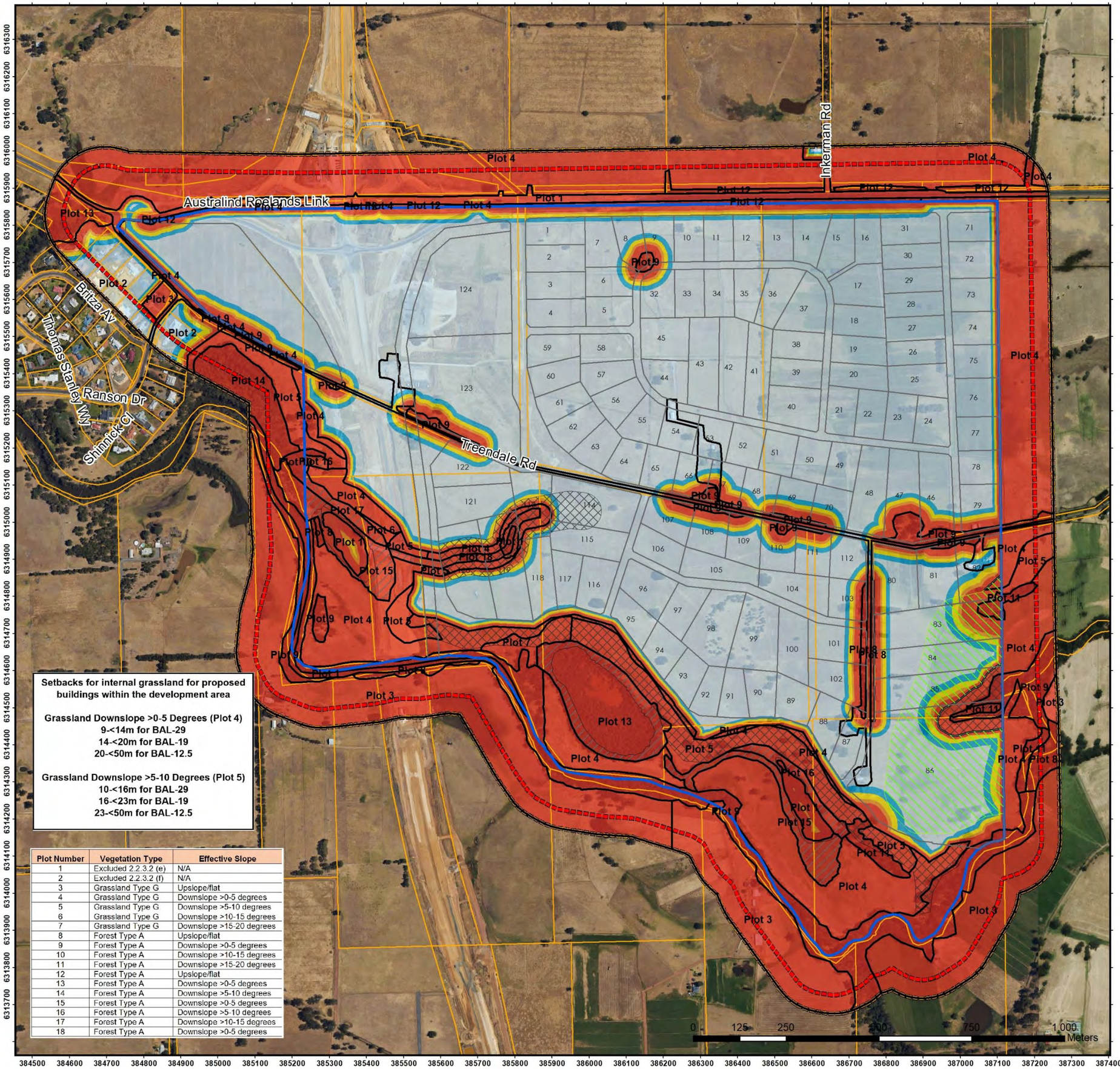
- Method 1 (AS3959-2018) Simplified procedure was used for vegetation classification and BAL Assessment process;
- The BAL Contour Plan was prepared by an Accredited Level 2 Bushfire Planning Practitioner (BPAD37893);
- The BAL Contour Map has been prepared in accordance with Department of Planning (WAPC) Guidelines for Planning in Bushfire Prone Areas (Appendix 3, Version 1.3, 2017);
- The structure plan amendment is as per the amended structure plan supplied by proponent (Figure 2);
- Subject site is located partially within in a Bushfire Prone Area, see Figure 3 (OBRM, 2021);
- Internal vegetation (Part of Plot 9 Forest), located central south in the subject site (see future low fuel in Figure 4 Vegetation Classes), has been excluded from BAL contouring as it is expected that in the future, this vegetation can be removed/modified to a low threat state and managed in perpetuity; and
- Internal Grassland area within the subject site (Part of Plot 4 and Plot 5) has been excluded from the BAL Contour mapping and setback distances shown on the BAL Contour map to indicate requirements to achieve BAL-29 or below.

Note on internal grassland areas:
The lot contains significant areas of internal grasslands which are mapped as bushfire hazards (refer to Vegetation Classes Map). For practical purposes and to assist in identifying areas of 'least risk', the internal grasslands within the subject site (Part of Plot 4 and Plot 5) has been excluded from the BAL contour mapping. Setback distances to these areas are to be as per AS3959 and the following to apply:

Plot 4 – Grassland >0-5 degrees
9-<14m for BAL 29
14-<20m for BAL 19
20-<50m for BAL 12.5

Plot 5 – Grassland >5-10 degrees
10-<16m for BAL 29
16-<23m for BAL 19
23-<50m for BAL 12.5

When the final placement of the dwellings is known APZ areas are to apply as per the allocated BAL for the dwelling.



Setbacks for internal grassland for proposed buildings within the development area

Grassland Downslope >0-5 Degrees (Plot 4)
9-<14m for BAL-29
14-<20m for BAL-19
20-<50m for BAL-12.5

Grassland Downslope >5-10 Degrees (Plot 5)
10-<16m for BAL-29
16-<23m for BAL-19
23-<50m for BAL-12.5

Plot Number	Vegetation Type	Effective Slope
1	Excluded 2.2.3.2 (e)	N/A
2	Excluded 2.2.3.2 (f)	N/A
3	Grassland Type G	Upslope/flat
4	Grassland Type G	Downslope >0-5 degrees
5	Grassland Type G	Downslope >5-10 degrees
6	Grassland Type G	Downslope >10-15 degrees
7	Grassland Type G	Downslope >15-20 degrees
8	Forest Type A	Upslope/flat
9	Forest Type A	Downslope >0-5 degrees
10	Forest Type A	Downslope >10-15 degrees
11	Forest Type A	Downslope >15-20 degrees
12	Forest Type A	Upslope/flat
13	Forest Type A	Downslope >0-5 degrees
14	Forest Type A	Downslope >5-10 degrees
15	Forest Type A	Downslope >0-5 degrees
16	Forest Type A	Downslope >5-10 degrees
17	Forest Type A	Downslope >10-15 degrees
18	Forest Type A	Downslope >0-5 degrees

This BAL Plan was prepared by:
Kathryn Kinnear, Bio Diverse Solutions
Accreditation No: BPAD30794
Jurisdiction: Level 2 - WA

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

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Overview Map Scale 1:100,000

Legend

- Subject Site
- 100m Assessment Boundary
- 150m Assessment Boundary
- Cadastre
- Proposed Lot Layout 02-2023
- Wetland Buffers
- Revegetation Extents (Refer to Wetland Management Plan)
- Proposed Development Exclusion Area
- Vegetation/Plot Boundary

BAL Contours

- BAL-FZ
- BAL-40
- BAL-29
- BAL-19
- BAL-12.5
- BAL-LOW

Scale
1:10,000 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

CLIENT

Tecon Australia
Treendale Structure Plan, Treendale Road
Roelands, WA 6226

Figure 5: BAL Allocation (Contour) Plan

BAL Assessor	*QA Check*	*Drawn by*
JRB	**KPK**	**GSK**
STATUS	*FILE*	*DATE*
FINAL	**MSC0285-001**	**09/03/2023**

Table 4: BAL Allocation Plan of Amended Structure Plan

Method 1 BAL Determination					
Plot Number	**Vegetation Type (Table 2.3)**	**Slope (Table 2.4.3)**	**Distance to Vegetation (m)**	**Highest BAL Contour**	**Modified BAL Contour**
3	Grassland Type G	Upslope/flat	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
4	Grassland Type G	Downslope >0-5 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
5	Grassland Type G	Downslope >5-10 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
6	Grassland Type G	Downslope >10-15 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
7	Grassland Type G	Downslope >15-20 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
8	Forest Type A	Upslope/flat	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
9	Forest Type A	Downslope >0-5 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
10	Forest Type A	Downslope >10-15 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
11	Forest Type A	Downslope >15-20 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
12	Forest Type A	Upslope/flat	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
13	Forest Type A	Downslope >0-5 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
14	Forest Type A	Downslope >5-10 degrees	12m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
15	Forest Type A	Downslope >0-5 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
16	Forest Type A	Downslope >5-10 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
17	Forest Type A	Downslope >10-15 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail
18	Forest Type A	Downslope >0-5 degrees	0m	BAL-FZ	BAL 12.5 and BAL-Low can prevail

Note: Some vegetation is within the subject site and has no separation from the classified vegetation. Vegetation onsite is under the control of the landowner. Therefore, can be removed or modified to a low threat state. As a result, onsite vegetation within the subject site (Part of Plot 4 and Plot 5 Grassland and a small portion of Plot 9 Forest) has been excluded from the BAL Contour mapping over the proposed lot. It is expected that this vegetation can be removed or modified to a low threat state to the extent that all new proposed dwellings can be located in BAL-29 or lower. Vegetation offsite is not within the control of the landowner and therefore the vegetation cannot be removed or modified. As a result, the BAL impact from these vegetation areas is unable to be reduced. Revegetation plots (15, 16, 17 and 18) have been considered and is expected future dwellings will be located sufficient distance from future classified vegetation to achieve BAL-29 or lower.

3.7 Habitable Buildings on the Subject Site - BAL Rating

Existing habitable dwellings within the development area are currently subject to or have the ability to achieve BAL-29 or lower. The existing dwellings have largely been contained within individual proposed lots with an approximate size of 1ha with the exception of the house on Lot 878 which will likely be the subject to resumption/compensation through the Main Roads BORR acquisition process. Refer to BAL Contour Plan Figure 5.

4 Identification of bushfire hazard issues

The identified bushfire risks associated with the subject site is the continuous vegetation running along the river bank to the south of the SP area and the small patches of remnant vegetation within the subject site. These areas present as predominantly Forest Type A and downslope in relation to the development area. Under hot, dry and unstable conditions (Severe to catastrophic/bushfire weather) the subject site is most at risk from bushfire from this direction.

The predominant onsite vegetation is Grassland Type G and is expected that in the future this vegetation can be managed as low threat vegetation or in a non-vegetated state to the extent required so that any proposed new dwelling can achieve BAL-29 or lower.

It is expected that when the revegetation areas reach maturity, they will present as Class A Forest. These areas have been factored into the classified vegetation over the site and the BAL impact from these plots is represented in Figure 5 BAL Contour Plan.

If the structure plan amendment is approved, ongoing management of vegetation compliance is regulated via the Bushfire Management Plan for the site and the prevailing Shire of Harvey Firebreak Order. Bushfire management measures external to the site are not required as part of this proposal.

More detailed BAL Contour plans will be prepared in subsequent stages of planning and as the design development occurs.

Water Supply

A reticulated water supply is available to the west of the subject site on Treendale Road. Hydrants will be installed as per the technical requirements established by the guidelines. A fire hydrant plan may be required at subdivision stage to show the location and spacing of the hydrants. Amendments to the BMP may be required to address water supply in subsequent stages of the planning process as more detailed engineering is available.

Access

Treendale Road, Raymond Road and the construction of an internal road network will provide safe access and egress to two different destinations. The western section of Treendale Road will possibly be cut off and potentially closed as part of the Bunbury Outer Ring Road (BORR) project, this will create temporary cul-de-sacs that in the future will be linked with an Emergency Access Way or a Public Road post construction of the BORR once confirmation of the status of the existing road network is confirmed. Amendments to the BMP may be required to address water supply in subsequent stages of the planning process as more detailed engineering is available.

5 Assessment to the bushfire protection criteria

The Guidelines for Planning in Bushfire Prone Areas (WAPC, 2017) outlines bushfire protection criteria which subdivision and development proposals are assessed for compliance. The bushfire protection criteria (Appendix 4, WAPC, 2017) are a performance-based criteria utilised to assess bushfire risk management measures and they outline four elements, being:

- Element 1: Location
- Element 2: Siting and Design of Development;
- Element 3: Vehicle Access; and
- Element 4: Water.

The subject site and the amended structure plan will be assessed and are required to meet the “Acceptable Solutions” of each element of the bushfire mitigation measures (WAPC, 2017). The proposal will be assessed against all elements of the bushfire protection criteria, refer to Table 5.

Table 5: Bushfire protection criteria applicable to the site

Element	Acceptable Solution	Applicable or not Yes/No	Structure Plan meets Acceptable Solution
Element 1 – Location	A1.1 Development Location	Yes	Compliant The proposal achieves compliance by ensuring future buildings can be located in an area that will upon completion be exposed to a BAL Rating of no higher than BAL-29. This can be achieved by with appropriate positioning, design and onsite vegetation management, see Figure 5 BAL Contour Plan. Existing buildings are located within BAL-29 or lower, some of the existing buildings will be the subject to resumption/compensation through the Main Roads BORR acquisition process. Proposal meets Acceptable Solution A1.1
Element 2 – Siting and Design	A2.1 Asset Protection Zone (APZ)	Yes	Compliant The proposal can meet compliance by ensuring future building work on the lot/s can have established around them an APZ of the required dimensions to achieve BAL-29 or lower. Lots are a proposed a minimum of 1 hectare in size which is deemed sufficient area available to meet required low fuel standards to achieve BAL 29 or less. APZ areas will be contained solely within the individual lots and will be managed to Schedule 1 WAPC standards as presented in Appendix B of this report. Future landowner/s will have the responsibility of managing the required APZ in a low threat state including ongoing compliance with the local government's annual firebreak notice. Existing buildings are located within BAL-29 or lower, some of the existing buildings will be the subject to resumption/compensation through the Main Roads BORR acquisition process. Proposal meets Acceptable Solution A2.1
Element 3 – Vehicular Access	A3.1 Two Access Routes	Yes	Compliant Treendale Road, Raymond Road and the construction of an internal road network will provide safe access and egress to two different destinations. The western section of Treendale Road will possibly be cut off and potentially closed as part of the Bunbury Outer Ring Road project, this will create temporary cul-de-sacs that in the future will be linked with an Emergency Access Way or a Public Road post construction of the BORR once confirmation of the status of the existing road network is confirmed. Proposal meets Acceptable Solution A3.1
	A3.2 Public Road	Yes	Compliant All new public roads will be constructed to meet the construction technical requirements as outlined by the current endorsed guidelines. See Table 6 for the technical requirements for public roads. This is to be noted for future engineering designs of the SP. Proposal meets Acceptable Solution A3.2

Table 5 cont.

Element	Acceptable Solution	Applicable or Not Yes/No	Structure Plan meets Acceptable Solution
Element 3 – Vehicular Access	A3.3 Cul-de-sacs	Yes	Compliant There is one proposed cul-de-sac to the south-east of the development area, this cul-de-sac is for public access to the foreshore and does not directly service any of the future lots and there for is considered in this assessment. The western section of Treendale Road will possibly be cut off and potentially closed as part of the Bunbury Outer Ring Road project, this may create temporary cul-de-sacs that in the future will be linked with an Emergency Access Way or a Public Road post construction of the BORR once confirmation of the status of the existing road network is confirmed. In the future, all temporary cul-de-sacs that service proposed lots will be linked so as not to create any permanent cul-de-sac road. This can only be established in subsequent planning stages and once it is established the outcome for the existing Treendale Road. Proposal meets Acceptable Solution A3.3
	A3.4 Battle axes	No	No battle axes are proposed. Not assessed to A3.4
	A3.5 Private driveways	Yes	Compliant Internal driveways are to be installed to the lots by the new lot owner when building locations are defined and are to meet minimum technical requirements as shown in Table 6. Proposal meets Acceptable Solution A3.5
	A3.6 Emergency Access Ways	Yes	Compliant The requirement for the construction of Emergency Access Ways will be established post construction of the Bunbury Outer Ring Road, if existing Treendale Road is cut off or closed for the outer ring road, an Emergency Access Way will possibly be utilised to link the temporary cul-de-sacs. This will be detailed in subsequent levels of planning. Proposal meets Acceptable Solution A3.6
	A3.7 Fire Service Access Ways	No	No FSA's are proposed as the public road network will be utilised. Not assessed to A3.7.
	A3.8 Firebreaks	Yes	Compliant New lots are to be managed to the current Shire of Harvey Firebreak Order. Proposal meets Acceptable Solution A3.8

Table 5 cont.

Element	Acceptable Solution	Applicable or Not Yes/No	Structure Plan meets Acceptable Solution
Element 4 – Water	A4.1 Reticulated areas	Yes	Compliant A reticulated water supply is available to the west of the subject site on Treendale Road. Hydrants will be installed as per the technical requirements established by the guidelines. This will be detailed in subsequent levels of planning. Proposal meets Acceptable Solution A4.1
	A4.2 Non-reticulated areas	No	Not assessed to A4.2.
	A4.3 Individual lots in non-reticulated areas	No	Not assessed to A4.3.

6 Other Fire Mitigation Measures

The purpose of this section of the report is to detail specific onsite vegetation management requirements such as the APZ dimensions, management of Public Open Space or application of landscaping plans.

6.1 Vehicle Access requirements

All new access and private driveways will be constructed to the standards as stated in the current and endorsed WAPC (2017) guidelines, refer to Table 6

Table 6: Vehicular Access Technical Requirements (WAPC, 2017)

Technical requirements	Public Roads	Private Driveways	Emergency Access Ways
Minimum trafficable surface (m)	6*	4	6*
Horizontal clearance (m)	6	6	6
Vertical clearance (m)	4.5	4.5	4.5
Maximum grades	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5	8.5
Maximum Length	N/A	50m	600m

*Denotes the width can include a 4m wide paving with one metre wide constructed road shoulders

6.2 BAL-29 or less Asset Protection Zones

All proposed new dwellings will be required to have an APZ that will ensure a BAL rating of BAL-29 or lower is achieved, refer to Table 7 below for the required separation distance to achieve BAL-29 for each area of vegetation.

Table 7: Separation Distances to achieve BAL-29 from each Vegetation Plot (BAL-29 APZ)

BAL-29 Asset Protection Zone				
Vegetation Plot	**Applied Vegetation Classification**	**Effective Slope (degrees)**	**BAL Rating**	**Required Separation Distance (metres)**
1	Excluded 2.2.3.2 (e)	N/A	BAL-29	-
2	Excluded 2.2.3.2 (f)	N/A		-
3	Grassland Type G	Upslope/Flat		8
4	Grassland Type G	0-5˚ D/S		9
5	Grassland Type G	5-10˚ D/S		10
6	Grassland Type G	10-15˚ D/S		12
7	Grassland Type G	15-20˚ D/S		14
8	Forest Type A	Upslope/Flat		21
9	Forest Type A	0-5˚ D/S		27
10	Forest Type A	10-15˚ D/S		42
11	Forest Type A	15-20˚ D/S		52
12	Forest Type A	Upslope/Flat		21
13	Forest Type A	0-5˚ D/S		27
14	Forest Type A	5-10˚ D/S		33
15	Forest Type A	0-5˚ D/S		27
16	Forest Type A	5-10˚ D/S		33
17	Forest Type A	10-15˚ D/S		42
18	Forest Type A	0-5˚ D/S		27

6.3 Evaporative air conditioners

Evaporative air conditioning units can catch fire as a result of embers from bushfires entering the unit. These embers can then spread quickly through the home causing rapid destruction. It can be difficult for fire-fighters to put out a fire in the roof spaces of homes.

It is also recommended that land owners:

- Ensure that suitable external ember screens are placed on roof top mounted evaporative air conditioners compliant with AS3959-2018 (current and endorsed standards) and that the screens are checked annually; and
- Maintain evaporative air conditioners regularly as per DFES recommendations, refer to the DFES website for further details:

  http://www.dfes.wa.gov.au

6.4 Barrier Fencing

In November 2010 the Australian Bushfire CRC issued a "Fire Note" (Bushfire CRC, 2010) which outlined the potential for residential fencing systems to act as a barrier against radiant heat, burning debris and flame impingement during bushfire. The research aimed to observe, record, measure and compare the performance of commercial fencing of Colourbond steel and timber (treated softwood and hardwood).

The findings of the research found that:

".. *Colourbond steel fencing panels do not ignite and contribute significant heat release during cone calorimeter exposure"* (exposure to heat)

.."Colourbond steel (fencing) had the best performance as a non-combustible material. It maintained structural; integrity as a heat barrier under all experimental exposure conditions, and it did not spread flame laterally and contribute to fire intensity during exposure"

It is also noted that non-combustible fences are recommended by Schedule 1 WAPC (APZ standards: Fences and sheds within the APZ are constructed using non-combustible materials e.g. colourbond iron, brick, limestone, metal post and wire). The developer and future land owners will be encouraged to build Colourbond or non-combustible fences where applicable.

7 Responsibilities for implementation

7.1 Future Lot owner's Responsibility

It is recommended the future property owners shall be responsible for the following:

Table 8: – Implementation actions future lot owners

Future Lot owner– Ongoing management				
No	**Implementation Action**	**Initial**	**Annual**	**All times**
1	Build to AS3959 as it applies to their property	✓		
2	Establish/maintain APZ's to the standard stated in this BMP	✓		
3	Maintain individual lot fuels in accordance with Schedule 1 WAPC APZ standards (Appendix B).		✓	
4	Construct/maintain private driveways to the standards stated in Table 6.	✓		

7.2 Developer's responsibility

It is recommended the developer be responsible for the following:

Table 9: – Implementation actions current land owners/developer

Developer – Prior to issue of titles		
No	**Implementation Action**	**Subdivision Clearance**
1	Planning approval may be conditioned with the requirement to make appropriate notifications (on the certificates of title and the deposited plan), of the existence of this Bushfire Management Plan and that the land is within a designated bushfire prone area. A Notification, pursuant to Section 165 of the Planning and Development Act 2005 may be required to be placed on the certificate(s) of title of the proposed lot(s) with a Bushfire Attack Level (BAL) rating of 12.5 or above, advising of the existence of a hazard or other factors. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows: • *'This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and is subject to a Bushfire Management Plan. Additional planning and building requirements apply to development on this land'.*	✓
2	Ensure prospective buyers are aware of the BAL Contour Plan and the applicable BAL to their property through provision of BAL Contour Plan. Update the BAL contour plan and provide certification of BAL Contour prior to lodgement of titles (post construction).	✓
3	Ensure lots are compliant with the relevant local government's annual firebreak notice issued under s33 of the Bushfires Act 1954.	✓
4	Construct public roads to the standards stated in this BMP (Table 7).	✓
5	Establish the outcome for the western section of Treendale Road and implement the required Emergency Access Way or Public Road to ensure none of the proposed lots are serviced by cul-de-sac road access, this will be completed post construction of the Bunbury Outer Ring Road.	✓
6	Implement revegetation works to the standards stated in the BMP and the associated Wetland Management Plan.	✓
7	Install reticulated water supply to the standards stated in this BMP.	✓
8	Update or review this BMP report as required or as further planning or design information is available to assist through subsequent levels of WAPC planning.	✓

9	Implement the low fuel area indicated as future low fuel on Figure 4 Vegetation Classification Map at the WAPC approval stage.	✓

7.3 Local Government Responsibility

It is recommended the local government be responsible for the following:

Table 10: – Implementation actions Shire of Harvey

LGA– Clearance of conditions			
No	**Implementation Action**	**Subdivision Clearance**	**Ongoing**
1	Request for the update of the BAL contour plan and certification of BAL Contour prior to clearance of titles (post construction).	✓	✓
2	Ensure vehicle access standards are achieved as per Table 7.	✓	
3	Monitor landowner compliance with the Bushfire Management Plan and the annual Shire of Harvey Firebreak Order.	✓	✓
4	Where control of an area of vegetated land is vested in the control of the local government and that area of land has potential to influence the assessed BAL rating/s of future buildings - there is an obligation to consider the impact of any changes to future vegetation management and/or revegetation plans with respect to that area.	✓	✓
5	The wetland revegetation areas are required to be maintained to no higher than the classification indicated in Figure 4.	✓	✓

8 Disclaimer

The recommendations and measures contained in this assessment report are based on the requirements of the Australian Standards 3959-2018 – Building in Bushfire Prone Areas, WAPC State Planning Policy 3.7 (WAPC, 2015), WAPC Guidelines for Planning in Bushfire Prone Areas (WAPC, 2017), and CSIRO's research into Bushfire behaviour. These are considered the minimum standards required to balance the protection of the proposed dwelling and occupants with the aesthetic and environmental conditions required by local, state and federal government authorities. They DO NOT guarantee that a building will not be destroyed or damaged by a bushfire. All surveys and forecasts, projections and recommendations made in this assessment report and associated with this proposed dwelling are made in good faith on the basis of the information available to the fire protection consultant at the time of assessment. The achievement of the level of implementation of fire precautions will depend amongst other things on actions of the landowner or occupiers of the land, over which the fire protection consultant has no control. Notwithstanding anything contained within, the fire consultant/s or local government authority will not, except as the law may require, be liable for any loss or other consequences (whether or not due to negligence of the fire consultant/s and the local government authority, their servants or agents) arising out of the services rendered by the fire consultant/s or local government authority.

AS3959-2018 disclaimer: It should be borne in mind that the measures contained within this Standard (AS3959-2018) cannot guarantee that a building will survive a bushfire event on every occasion. This is substantially due to the unpredictable nature and behaviour of fire and extreme weather conditions.

Building to AS39590-2018 is a standard primarily concerned with improving the ability of buildings in designated bushfire prone areas to better withstand attack from bushfire thus giving a measure of protection to the building occupants (until the fire front passes) as well as to the building itself (AS3959, 2018).

9 Certification

I hereby certify that I have undertaken the assessment of the above site and determined the Bushfire Attack Level stated above in accordance with the requirements of AS 3959-2018 (Incorporating Amendment Nos 1, 2 and 3) and the Guidelines for Planning in Bushfire Prone Areas Ver 1.3 (WAPC, 2017).

SIGNED, ASSESSOR: ..... DATE: 9/03/2023

Jason Benson Bio Diverse Solutions
Accredited Level 2 Bushfire Practitioner (Accreditation No: BPAD37893)

10 References

AS3959-2018 Australian Standard, Construction of buildings in bushfire-prone areas, Building Code of Australia, Primary Referenced Standard, Australian Building Codes Board and Standards Australia.

Shire of Harvey Firebreak Order 2022/2023, accessed from: bushfire-brochure-2022-2023 (harvey.wa.gov.au)

OBRM, Office of Bushfire Risk management (2021). Map of Bushfire Prone Areas. Data retrieved from State Land Information Portal (SLIP) https://maps.slip.wa.gov.au/landgate/bushfireprone/

Western Australian Planning Commission (WAPC) (2017) Guidelines for Planning in Bushfire Prone Areas Version 1.3. Western Australian Planning Commission and Department of Planning WA, Government of Western Australia.

Western Australian Planning Commission (WAPC) (2015) State Planning Policy 3.7 Planning in Bushfire Prone

11 Appendices

Appendix A – Vegetation Classifications to AS3959

Appendix B – Schedule 1 WAPC Asset Protection Zone (APZ) standards to apply

Appendix C – Firebreak Notice and Bush Fire Information 2022/23

Appendix A

Vegetation Classification to AS3959

Vegetation classification to AS3959-2018

Site Details			
Address:	Lots 1, 2, 3, 100, 121, 246, 314, 878 and 3315 Treendale Road		
Suburb:	Roelands	**Suburb:**	Roelands
Local Government Area:	Shire of Harvey		
Stage of WAPC Planning	Structure Plan		

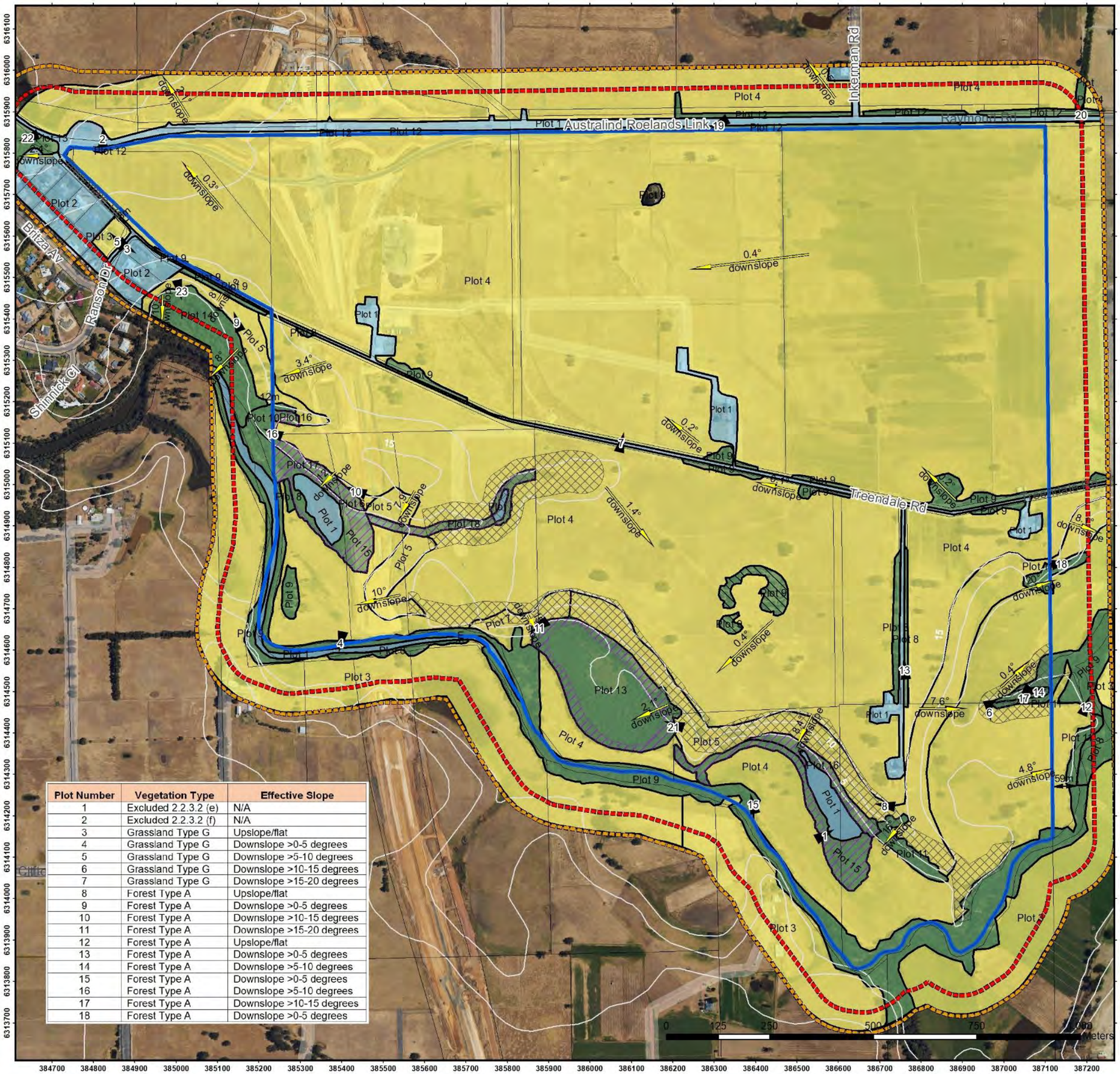
BMP Plan Details			
Report / Job Number:	MSC0285	**Report Version:**	Final
Assessment Date:	25 June 2020	**Report Date:**	9 March 2023
BPAD Practitioner	Jason Benson	**Accreditation No.**	BPAD 37893

Vegetation Classification

Site assessment occurred on the 25th and 26th June 2020 by Jason Benson (BPAD 37893). All vegetation within 150m of the site / proposed development was classified in accordance with Clause 2.2.3 of AS3959-2018. Each distinguishable vegetation plot with the potential to determine the Bushfire Attack Level is identified in the following pages and shown on the Vegetation Classes Map Page 3.

Plot number	Vegetation Type (Table 2.3)	Slope (Table 2.4.3)
1	Excluded 2.2.3.2 (e)	N/A
2	Excluded 2.2.3.2 (f)	N/A
3	Grassland Type G	Upslope/flat
4	Grassland Type G	Downslope >0-5 degrees
5	Grassland Type G	Downslope >5-10 degrees
6	Grassland Type G	Downslope >10-15 degrees
7	Grassland Type G	Downslope >15-20 degrees
8	Forest Type A	Upslope/flat
9	Forest Type A	Downslope >0-5 degrees
10	Forest Type A	Downslope >10-15 degrees
11	Forest Type A	Downslope >15-20 degrees
12	Forest Type A	Upslope/flat
13	Forest Type A	Downslope >0-5 degrees
14	Forest Type A	Downslope >5-10 degrees
15	Forest Type A	Downslope >0-5 degrees
16	Forest Type A	Downslope >5-10 degrees
17	Forest Type A	Downslope >10-15 degrees
18	Forest Type A	Downslope >0-5 degrees

Note Plots 15 – 18 are future revegetation areas



Plot Number	Vegetation Type	Effective Slope
1	Excluded 2.2.3.2 (e)	N/A
2	Excluded 2.2.3.2 (f)	N/A
3	Grassland Type G	Upslope/flat
4	Grassland Type G	Downslope >0-5 degrees
5	Grassland Type G	Downslope >5-10 degrees
6	Grassland Type G	Downslope >10-15 degrees
7	Grassland Type G	Downslope >15-20 degrees
8	Forest Type A	Upslope/flat
9	Forest Type A	Downslope >0-5 degrees
10	Forest Type A	Downslope >10-15 degrees
11	Forest Type A	Downslope >15-20 degrees
12	Forest Type A	Upslope/flat
13	Forest Type A	Downslope >0-5 degrees
14	Forest Type A	Downslope >5-10 degrees
15	Forest Type A	Downslope >0-5 degrees
16	Forest Type A	Downslope >5-10 degrees
17	Forest Type A	Downslope >10-15 degrees
18	Forest Type A	Downslope >0-5 degrees

This BAL Plan was prepared by:
Kathryn Kinnear, Bio Diverse Solutions
Accreditation No: BPAD30794
Jurisdiction: Level 2 - WA

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

BIO DIVERSE SOLUTIONS

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Overview Map Scale 1:100,000

Legend

- Subject Site
- 100m Assessment Boundary
- 150m Assessment Boundary
- Cadastre
- 5m Contours
- Separation Distance
- Slope Degrees
- Photo Point
- Wetland Buffers
- Revegetation Extents (Refer to Wetland Management Plan)
- Future Low Fuel
- Vegetation/Plot Boundary

Vegetation

- Forest Type A
- Woodland Type B
- Grassland Type G
- Low fuel or non vegetated 2.2.3.2

Scale
1:9,000 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

CLIENT
Tecon Australia
Treendale Structure Plan, Treendale Road
Roelands, WA 6226

Vegetation Classes

BAL Assessor	*QA Check*	*Drawn by*
JB	**KK**	**SA**
STATUS	*FILE*	*DATE*
FINAL	**MSC0285-001**	**09/03/2023**

Plot	1	Classification or Exclusion Clause	Low fuel or non-vegetated areas exclusion 2.2.3.2 (e)

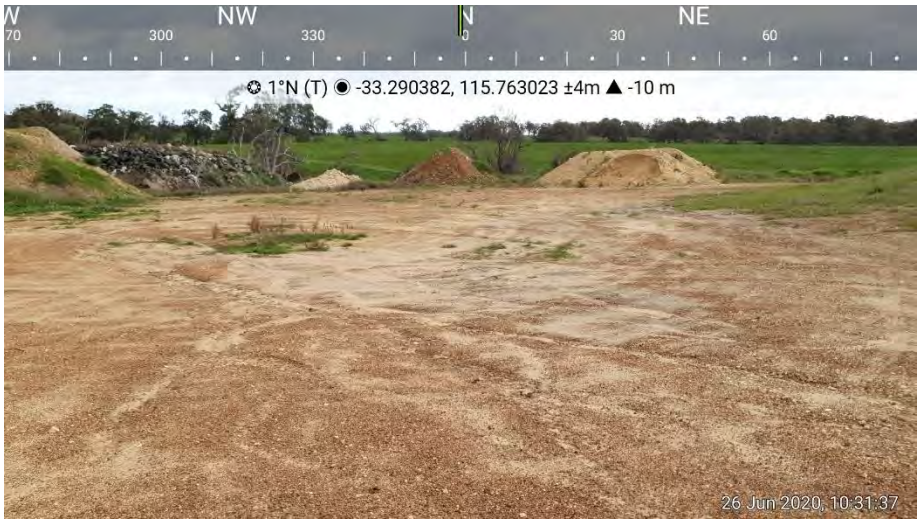
Location: External to the site to the north. Internal to the site through the middle running east-west as well as south and south-west of the subject site.

Description: Roads, driveways, buildings, seasonally inundated areas and other non-vegetated areas.

As per exclusion clause 2.2.3.2 (e) of AS3959-2018.

Photo Id 1: View facing north-east towards seasonally inundated area located central south to the subject site.

Plot	1 cont.	Classification or Exclusion Clause	Low fuel or non-vegetated areas exclusion 2.2.3.2 (e)



Additional Photo of Plot 1.

Photo Id 2: View facing north towards non-vegetated area located to the north-west of the subject site.

Plot	2	Classification or Exclusion Clause	Low fuel or non-vegetated areas exclusion 2.2.3.2 (f)

Location: North-west of the subject site.

Description: Managed Asset Protection Zones (APZ) in existing residential area including managed lawns and gardens.

Available fuel loading: <2 t/ha.

As per exclusion clause 2.2.3.2 (f) of AS3959-2018.

Photo Id 3: View to the south-east towards managed APZ area located to the north-west of the subject site.

Plot	3	Classification or Exclusion Clause	Grassland Type G

Location: South and west of the subject site.

Separation Distance: 0m along southern boundary. 18m to the north west.

Description Partially grazed mixed grasses and weeds.

Average vegetation height: 100-300mm.

Vegetation Coverage: <10% trees.

Available fuel loading: 4.5t/ha.

Effective slope: Upslope/Flat.

Photo Id 4: View facing south towards grassland vegetation located to the south of the subject site. Note: photo taken from southern boundary of the subject site looking across the Collie River.

Plot	3	Classification or Exclusion Clause	Grassland Type G
			**Additional Photo of Plot 3.**

Photo Id 5: View facing north-west towards grassland vegetation located in existing residential area to the north west of the subject site.

Plot	4	Classification or Exclusion Clause	Grassland Type G
			**Location:** Internal to the subject site and external to the north and east. **Separation Distance:** 0m to the internal and external vegetation. **Description** Partially grazed mixed grasses and weeds. **Average vegetation height:** 100-300mm. **Vegetation Coverage:** <10% trees. **Available fuel loading:** 4.5t/ha. **Effective slope:** Downslope >0-5 Degrees.

Photo Id 6: View facing south towards grassland vegetation located central east of the subject site.

Plot	4 cont.	Classification or Exclusion Clause	Grassland Type G
			**Additional Photo of Plot 4.**

Photo Id 7: View facing north towards grassland vegetation located in the north of the subject site, to the north of Treendale Road.

Plot	5	Classification or Exclusion Clause	Grassland Type G
			**Location:** Ridge line area internal to the subject site to the north of the wetland/floodplain areas. Extends outside the subject site along the western and eastern boundaries. **Separation Distance:** 0m. **Description** Partially grazed mixed grasses and weeds. **Average vegetation height:** 100-300mm. **Vegetation Coverage:** <10% trees. **Available fuel loading:** 4.5t/ha. **Effective slope:** Downslope >5-10 Degrees.

Photo Id 8: View facing west towards grassland vegetation located central south to the subject site.

Plot	5 cont.	Classification or Exclusion Clause	Grassland Type G
			**Additional Photo of Plot 5.**

Photo Id 9. View facing north towards grassland vegetation located to the west of the subject site.

Plot	6	Classification or Exclusion Clause	Grassland Type G
			**Location:** Internal to the subject site to the west adjacent to the wetland area. **Separation Distance:** 0m. **Description** Partially grazed mixed grasses and weeds. **Average vegetation height:** 100-300mm. **Vegetation Coverage:** <10% trees. **Available fuel loading:** 4.5t/ha. **Effective slope:** Downslope >10-15 Degrees.

Photo Id 10: View facing west north-west towards grassland vegetation located central west of the subject site.

Plot	7	Classification or Exclusion Clause	Grassland Type G

Location: Ridge line internal to the subject site to the south

Separation Distance: 0m.

Description Partially grazed mixed grasses and weeds.

Average vegetation height: 100-300mm.

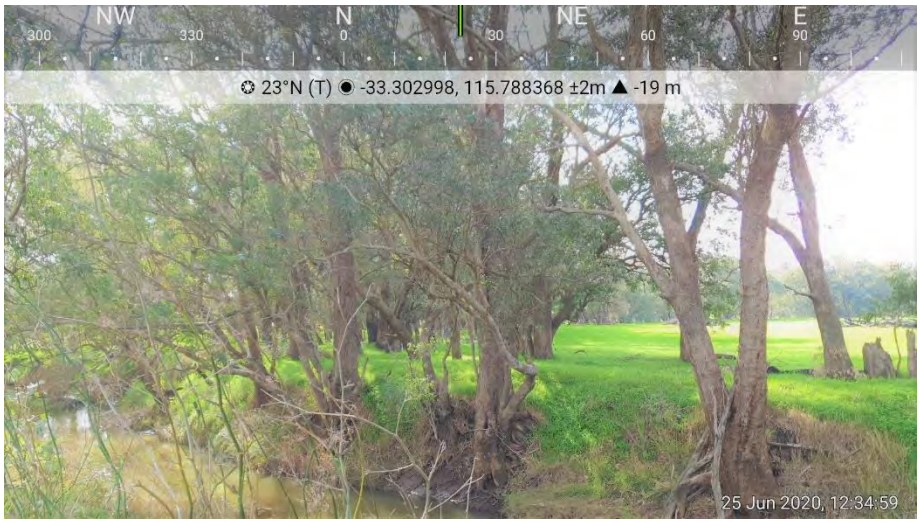
Vegetation Coverage: <10% trees.

Available fuel loading: 4.5t/ha.

Effective slope: Downslope >15-20 Degrees.

Photo Id 11: View facing south-west towards grassland vegetation located central south of the subject site.

Plot	8	Classification or Exclusion Clause	Forest Type A



Location: Internal to the site to the west and east. External to the site to the south and east of the subject site.

Separation Distance: 0m internal to the subject site. 59m to the east and 8m to the south.

Description: Mixed Eucalyptus and Melaleuca trees with grass understorey. No multilayering.

Average vegetation height: 10-20m.

Vegetation Coverage: 30-70% foliage cover.

Available fuel loading: 25-35t/ha.

Effective slope: Upslope/flat.

Photo Id 12: View facing north north-east towards forest vegetation located to the east of the subject site.

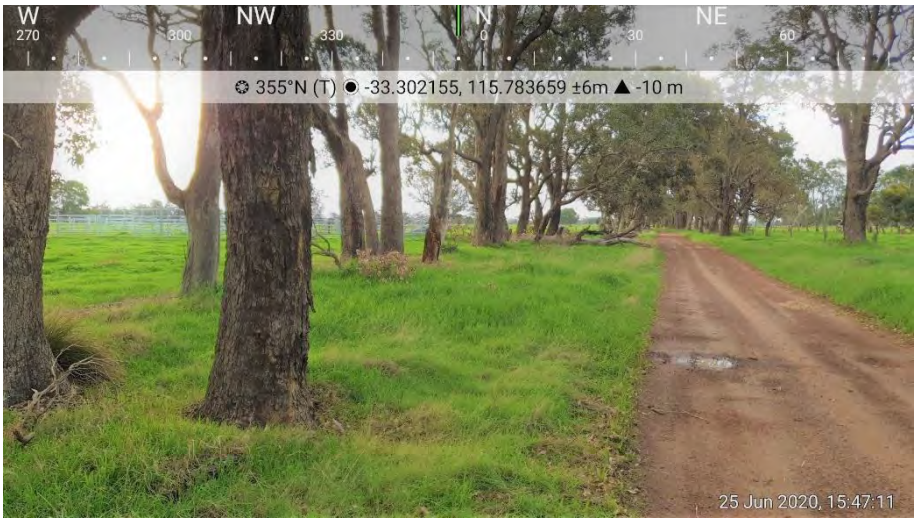
Plot	8 cont.	Classification or Exclusion Clause	Forest Type A
			**Additional Photo of Plot 8.**

Photo Id 13: View facing north towards forest vegetation located central east of the subject site.

Plot	9	Classification or Exclusion Clause	Forest Type A
			**Location:** Internal and external to the subject site to the east and north-west. **Separation Distance:** 0m to the boundary of the subject site in the north-east, south-east, south and south-west. **Description:** Mixed Eucalyptus and Melaleuca trees with grass understorey. No multilayering **Average vegetation height:** 10-20m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Downslope >0-5 Degrees.

Photo Id 14: View facing east towards forest vegetation located central east of the subject site.

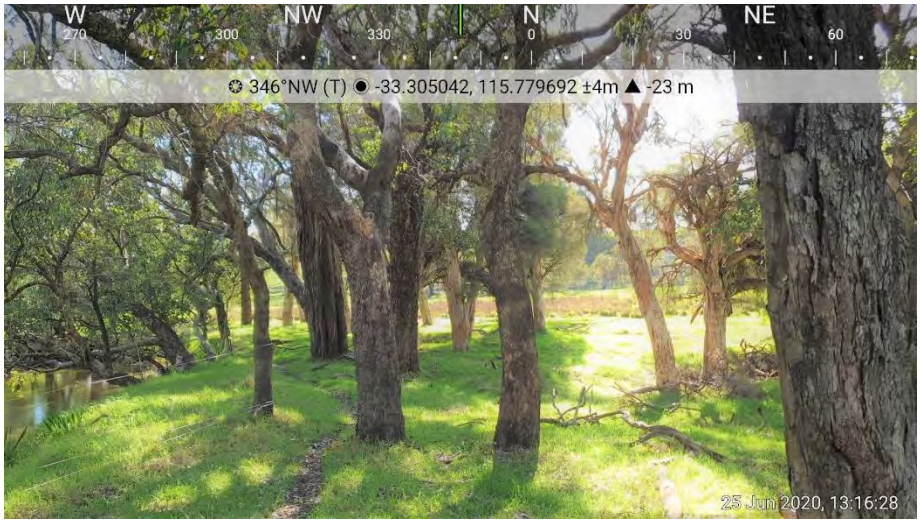
Plot	9 cont.	Classification or Exclusion Clause	Forest Type A
			**Additional Photo of Plot 9.**

Photo Id 15: View facing north towards forest vegetation located central south of the subject site.

Plot	10	Classification or Exclusion Clause	Forest Type A
			**Location:** Internal and external on the western boundary of the subject site. **Separation Distance:** 0m. **Description:** Mixed Eucalyptus and Melaleuca trees with grass understorey. No multilayering **Average vegetation height:** 10-20m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Downslope >10-15 Degrees.

Photo Id 16: View facing west north-west towards forest vegetation located central west of the subject site.

Plot	11	Classification or Exclusion Clause	Forest Type A
			**Location:** Internal and external to the site in the east and south-east. **Separation Distance:** 0m. **Description:** Mixed Eucalyptus and Melaleuca trees with grass understorey. No multilayering **Average vegetation height:** 10-20m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Downslope >15-20 Degrees.

Photo Id 17: View facing south-west towards forest vegetation located central east of the subject site.

Plot	11 cont.	Classification or Exclusion Clause	Forest Type A
			**Additional Photo of Plot 11.**

Photo Id 18: View facing south-west towards forest vegetation located central east of the subject site.

Plot	12	Classification or Exclusion Clause	Forest Type A
			**Location:** Thin strips of vegetation along Raymond Road to the north of the subject site. **Separation Distance:** 0m to the boundary of the subject site in the north. **Description:** Roadside vegetation and strips of plantation trees consisting of mixed Eucalyptus species. Dense canopy cover with a multilayered scrub understorey. **Average vegetation height:** 10-20m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Upslope/flat.

Photo Id 19: View facing south-west towards roadside vegetation on the south side of Raymond Road.

Plot	12 cont.	Classification or Exclusion Clause	Forest Type A
			**Additional Photo of Plot 12.**

Photo Id 20: View facing north towards thin strip of plantation trees located to the north of Raymond Road.

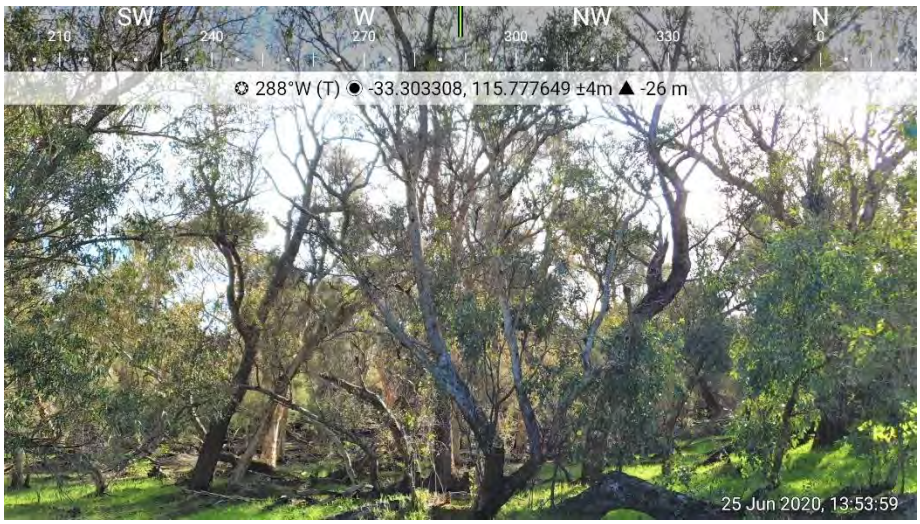
Plot	13	Classification or Exclusion Clause	Forest Type A
			**Location:** Internal to the subject site to the south and externally to the west. **Separation Distance:** 0m. **Description:** Mixed Eucalyptus and Melaleuca trees associated with low lying areas. Dense canopy cover with a multilayered scrub understorey. **Average vegetation height:** 8-12m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Downslope >0-5 Degrees. Note: the wetland in the south of the site is proposed to have some revegetation within the outer edges of the wetland. This has not been classified as a different plot (as revegetation plots 15 – 18 below) is it will not change the existing classification.

Photo Id 21: View facing west north-west towards Forest vegetation located central south of the subject site.

Plot	13 cont.	Classification or Exclusion Clause	Forest Type A
			**Additional Photo of Plot 14.**

Photo Id 22: View facing west south-west towards forest vegetation located to the west of the subject site.

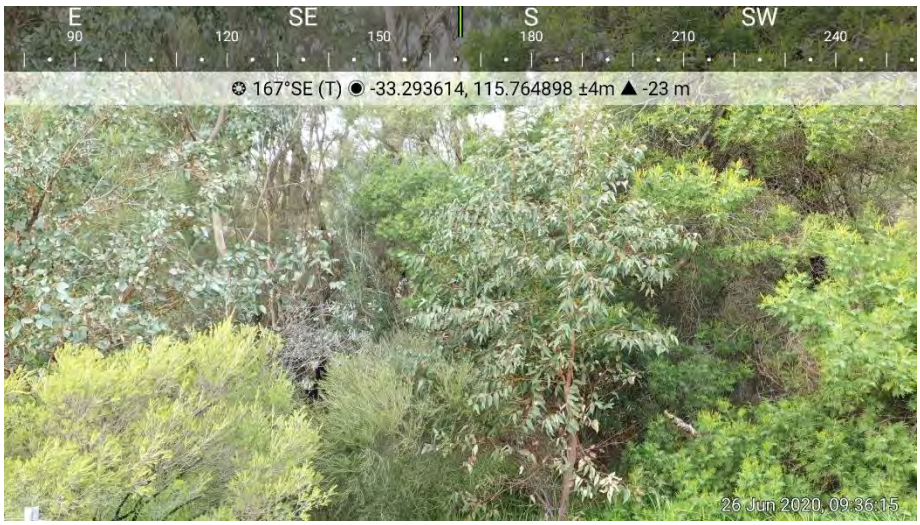
Plot	14	Classification or Exclusion Clause	Forest Type A
			**Location:** External to the subject site to the west. **Separation Distance:** 12m. **Description:** Eucalyptus, Melaleuca, Casuarina and Banksia trees. Dense canopy cover with a multilayers scrub understorey of Hakea, Acacia, shrubs, sedges and rushes. **Average vegetation height:** 10-20m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Downslope >5-10 Degrees.

Photo Id 23: View facing south towards forest vegetation located to the west of the subject site.

Plot	15	Classification or Exclusion Clause	Forest Type A
No Photo – Revegetation Area			**Location:** Internal to the subject site surrounding existing wetland areas to the west and south east. **Separation Distance:** 0m (internal) **Description:** Future revegetation area. Species composition is still to be finalised but it has been recommended an overstorey of *Eucalyptus rudis, Melaleuca rhaphiophylla* and occasional *Corymbia calophylla* be planted. Midstorey is proposed to consist of a mix of native shrubs such as Astartea, Melaleuca, Acacia and an understorey of mixed sedges. Has been classified as Forest Type A, as worst-case scenario. **Average vegetation height:** 10-20m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Downslope >0-5 Degrees.

Photo Id: N/A

Plot	16	Classification or Exclusion Clause	Forest Type A
No Photo – Revegetation Area			**Location:** Internal to the subject site surrounding existing wetland areas to the west and south east. **Separation Distance:** 0m (internal) **Description:** Future revegetation area. Species composition is still to be finalised but it has been recommended an overstorey of *Eucalyptus rudis, Melaleuca rhaphiophylla* and occasional *Corymbia calophylla* be planted. Midstorey is proposed to consist of a mix of native shrubs such as Astartea, Melaleuca, Acacia and an understorey of mixed sedges. Has been classified as Forest Type A, as worst-case scenario. **Average vegetation height:** 10-20m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Downslope >5-10 Degrees.
Photo Id: N/A			
Plot	**17**	**Classification or Exclusion Clause**	**Forest Type A**
No Photo – Revegetation Area			**Location:** Internal to the subject site surrounding existing wetland areas to the west. **Separation Distance:** 0m (internal) **Description:** Future revegetation area. Species composition is still to be finalised but it has been recommended an overstorey of *Eucalyptus rudis, Melaleuca rhaphiophylla* and occasional *Corymbia calophylla* be planted. Midstorey is proposed to consist of a mix of native shrubs such as Astartea, Melaleuca, Acacia and an understorey of mixed sedges. Has been classified as Forest Type A, as worst-case scenario. **Average vegetation height:** 10-20m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Downslope >10-15 Degrees.
Photo Id: N/A			

Plot	18	Classification or Exclusion Clause	Forest Type A
No Photo – Revegetation Area			**Location:** Located central west of the subject site to the south of Treendale Road (east of existing wetland area). **Separation Distance:** 0m (internal) **Description:** Future revegetation areas. Species composition is still to be finalised but it has been recommended an overstorey of *Eucalyptus rudis* and *Melaleuca rhaphiophylla* (approx. every 10m^2) be replanted in this area. The understorey is to consist of native sedges. It is anticipated the revegetation will grow back to a Forest Type A classification. **Average vegetation height:** 8-12m. **Vegetation Coverage:** 30-70% foliage cover. **Available fuel loading**: 25-35t/ha. **Effective slope:** Downslope >0-5 Degrees.
Photo Id: N/A			

COMMENTS ON VEGETATION CLASSIFCATIONS:

- Distances from vegetation were made based on surface fuels to edge of lot (subject site) boundary;
- Effective slopes were measured in the field using a Nikon Forestry Pro and represented on the respective plots;
- Method 1 (AS3959-2018) Simplified procedure was used for vegetation classification Assessment process;
- Due to the large assessment area representative photographs have been used for each plot of vegetation in this report, further photos of all plots are available if required;
- All vegetation was classified within the subject site and within 150m of the lot boundaries to AS3959 Table 2.3; and
- The perimeter of the vegetation was measured using field GPS and notations on field GIS maps.

CERTIFICATION

I hereby certify that I have undertaken the assessment of the above site and determined the Bushfire Attack Level stated above in accordance with the requirements of AS 3959-2018 (Incorporating Amendment Nos 1, 2 and 3).

SIGNED, ASSESSOR: ..... DATE: 27/07/2020

Jason Benson, Bio Diverse Solutions
Accredited Level 1 BAL Assessor (Accreditation No: BPAD37893)

REVISION RECORD

Revision	Prepared By	Summary	Reviewed By	Date
Draft Id	Jason Benson	Internal Review	Bianca Theyer	24/07/2020
Final Id	Jason Benson	Final Issued to Client	Kristy Richardson	31/07/2020
Final Id	Jason Benson	Mapping and Report amendments		9/03/2023

Appendix B

Schedule 1 WAPC Asset Protection Zone (APZ) standards to apply

Schedule 1
Standards for an Asset Protection Zone (APZ)

(WAPC, 2017)

Fences: Within the APZ are constructed from non-combustible materials (e.g. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.

Objects: Within 10 metres of a building, combustible objects must not be located close to the vulnerable parts of the building i.e. windows and doors.

Fine Fuel load: Combustible dead vegetation matter less than 6 millimetres in thickness reduced to and maintained at an average of two tonnes per hectare.

Trees (> 5 metres in height): Trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy. See Figure 11 (WAPC Figure 16, Appendix 4) below.

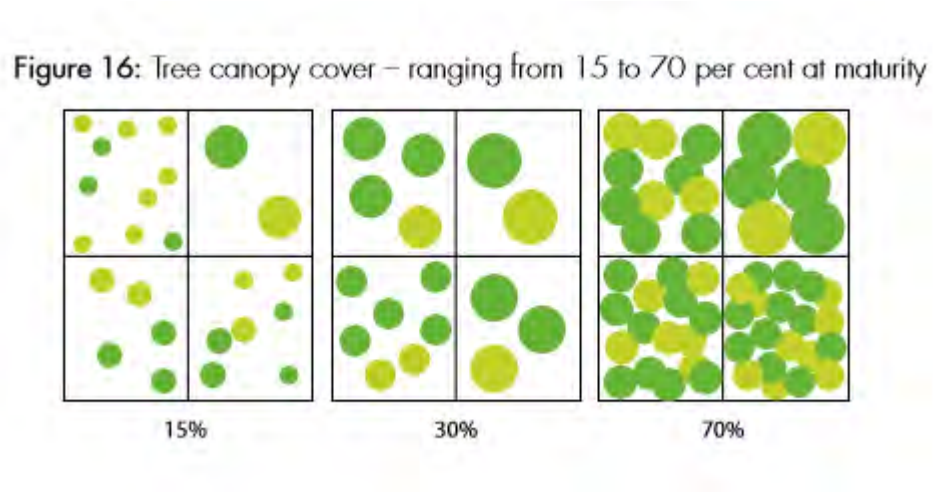


Figure 11 – Tree Canopy Cover

(WAPC, 2017)

Shrubs (0.5 metres to 5 metres in height): Should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m2 in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated as trees.

Ground covers (<0.5 metres in height): Can be planted under trees but must be properly maintained to remove dead plant material and any parts within 2 metres of a structure, but 3 metres from windows or doors if greater than 100 millimetres in height. Ground covers greater than 0.5 metres in height are to be treated as shrubs. –

Grass: Should be managed to maintain a height of 100 millimetres or less.

Appendix C

Firebreak Notice and Bush Fire Information 2022/23

SHIRE OF HARVEY

Firebreak Notice and Bush Fire Information

BUSH FIRE SEASON
2022–2023

REPORT ALL FIRES TO 000

For more information
harvey.wa.gov.au

Important dates

Firebreak/Hazard Prevention work to be completed by 30 November 2022

Firebreak/Hazard Prevention work to be maintained until 15 May 2023

Burning periods for the Shire of Harvey

RESTRICTED	2 November 2022 to 14 December 2022 (midnight)
PROHIBITED	15 December 2022 to 14 March 2023 (midnight)
RESTRICTED	15 March 2023 to 15 May 2023 (midnight)

Please note, the Restricted Burning Period dates are subject to change due to variable weather conditions.

You should always call your Bush Fire Control Officer or a Shire Ranger to check prior to lighting up.

Burning is prohibited on days where the Fire Danger Rating is High or above.

A Total Fire Ban may be declared at any time. If declared, a person must not light any fire or undertake any activity that may cause a fire.

Fire Danger Ratings change daily. To check the fire danger rating go to ***emergency.wa.gov.au***

Firebreak Notice

Responsibilities:

Notice is hereby given to all owners of land within the Shire of Harvey that pursuant to the powers conferred in Section 33 of the *Bush Fires Act 1954*, you are required to carry out fire prevention work in accordance with the requirements of this Notice, on or before 30 November 2022.

As a landowner you have a responsibility to manage your property to reduce the risk of bush fire. This notice informs you of what actions you must take to manage your property and the dates when those actions must be adhered to.

Infringements

The Shire will be inspecting properties for compliance from 1 December 2022.

The penalty for failing to comply with this Notice will/ may result in a fine being issued to the maximum of $5000. A person in default is also liable, whether prosecuted or not, to pay the costs of performing the work directed by this Notice if it is not carried out by the owner and/or occupier by the date required by this Notice.

Variations to this Notice

If you consider it to be impractical to meet the requirements of this Notice, you may apply and seek approval from the Shire in writing no later than **1 November 2022**. Please complete the form on the Shire's website *harvey.wa.gov.au/services/ fire-and-emergency-management* for permission to provide firebreaks in alternative positions or to take alternative action to abate fire hazards on the land.

Special Work Orders

The Shire retains the ability to issue Special Work Orders pursuant to Section 33 of the *Bush Fires Act 1954*, to individual landowners should additional works be necessary for a potential fire hazard that may exist on a property. These can be issued at any time during the year.

Bushfire Management Plan

All properties that are subject to a Bushfire Management Plan as a result of a subdivision or development approval or an approved treatment plan, must comply with the requirements of such plans in their entirety.

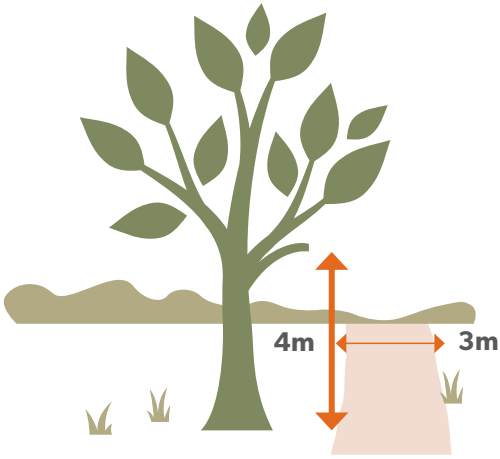
Firebreaks

Rural Land

Firebreaks not less than 3m wide with a 4m high Vertical Axis must be provided and maintained in the following positions:

- Located within 10m of all boundaries of the property/land.
- So as to divide the land into areas of not more than 120ha.
- Around all groups of buildings, haystacks and fuel installations but not closer than 6m.

Irrigated land that is kept fully watered and maintained in a non-flammable state for the whole of the Restricted and Prohibited burning periods may not require a firebreak.



Fuel and Gas Depots

Maintain the land clear of all flammable materials for 20m from any edge of the storage unit.

Plantations

Provide 15m wide firebreaks immediately adjoining to external boundaries of the planted area. The outer 10m be cleared of all flammable material while the inner 5m (closest to the trees) kept in a reduced fuel state.

Provide internal 6m wide firebreaks so as to divide the land into areas of not more than 30ha.

Fire Season Preparation

Residential/Special Residential exceeding 2024m²

Firebreak of at least 2m wide with a 4m high Vertical Axis must be provided and maintained in a non-flammable state within 6m of the property boundaries.

Cleared hardstand areas and reticulated grassed areas maintained in a green state are acceptable.

Residential/Special Residential 2024m² or less

All flammable material on the entire property (noting that this does not include living, standing trees, shrubs, plants and lawn under cultivation) is to be reduced and maintained to a height of less than 5cm.

Definitions

Firebreak

A strip of land which has been cleared of all flammable material such as wood, leaves and grass that is likely to be ignited and capable of burning. It must be trafficable, meaning it must be accessible by a fire appliance and cleared of vegetation to a maximum height of 5cm, without any obstruction to the vehicle. A firebreak cannot terminate or lead to a dead end.

Flammable Materials

Accumulated fuel such as leaf litter, twigs, bark, grass over 5cm high, timber boxes, cartons, paper and any combustible material, capable of carrying a running fire but excludes living standing trees and shrubs.

Residential/Special Residential Land

Includes land zoned Residential, Special Residential, Residential Development, Commercial and Industrial land within a townsite or any other area subdivided for residential purposes.

Rural land

Includes land zoned Special Rural, Intensive Farming, General Farming and Landscape Protection.

Flammable Fuel Storage

Includes all petroleum-based liquids, Liquefied Petroleum Gas, Liquefied Natural Gas, any other combustible liquid or gaseous fuel.

Definitions Continued

Hay Stack

Hay stack means any collection of hay including fodder rolls placed or stacked together that exceeds 100m^3 in size (eg 5m x 5m x 4m) whether in a shed, other structure of open air.

Strip of Land

Land cleared of all flammable materials, such as wood, leaves and grass that is likely to be ignited and capable of burning; it must be maintained throughout the period.

Irrigated Land /Hard Stand/ Reticulated Grass

Land that is kept fully watered and maintained in a non-flammable state for the whole of the Restricted and Prohibited burning periods.

Plantation

Any area exceeding 3ha planted for commercial gain. Including pine, eucalypt or other commercial value trees, excluding orchards and vineyards.

Special risks

Areas that adjoin public roads, railway reserves and power lines.

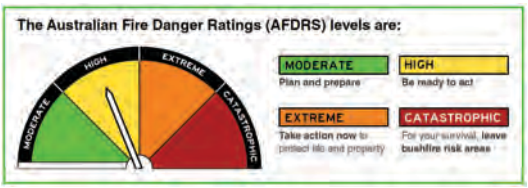
Trafficable

Trafficable means to be able to travel from one point to another in a four-wheel drive fire appliance on a clear surface, unhindered without any obstruction that may endanger such fire appliances.

Vertical Axis

A continuous vertical uninterrupted line at a right angle to the horizontal line of the firebreak.

Australian Fire Danger Ratings



For more information visit:
afac.com.au/initiative/afdrs

Burning

Total Fire Ban (TFB)

TFBs are declared by the Department of Fire and Emergency Services on days of extreme weather or when widespread fires are seriously stretching firefighting resources. TFBs are generally declared the evening before they take effect. To find out if a TFB has been declared visit *emergency.wa.gov.au* or tune in to ABC (684/720AM) on your radio.

When a TFB is declared it prohibits the lighting of any fires in the open air and any other activities that may start a fire.

The ban includes all open air fires for cooking or camping. It also includes incinerators, welding, grinding, soldering or gas cutting. For more information including exemptions visit *dfes.wa.gov.au/totalfirebans*.

Harvest and Vehicle Movement Bans (HVMB)

A HVMB, once declared by the Shire, prohibits all harvesting operations and all vehicle movements on a property (except prevention of an immediate and serious risk to the health or safety of a person or livestock, and only if all reasonable precautions have been taken).

HVMBs remain in place until midnight on the day called or until lifted (revoked) by the Shire.

A ban may be called on the basis of:
- Unfavourable fire weather conditions.
- Lack of firefighting resources due to existing commitments.
- Public holidays.

You can find out if a HVMB has been declared on the Shire's website *harvey.wa.gov.au* and Facebook page or by tuning into ABC (684/720AM) on your radio.

Burning of garden waste

Garden refuse (up to $1m^3$) may be lit outside the prohibited burning period only between 6pm and 11pm without a permit and must be completely extinguished with water or earth by midnight.

All flammable materials are to be cleared from within 5m of all points of the site of the fire and a person must be in attendance at all times until the fire is completely extinguished (only one pile to burnt at a time). Any incinerator to burn rubbish must be properly constructed and requires the approval from the Manager Environmental Health Services.

Note: Burning of garden refuse and incinerators is not permitted within the prohibited burning period or when the Fire Danger Rating for the day is high or above.

Permit To Burn

Permits to burn are required during Restricted Burning Periods and must be obtained from your local Bush Fire Control Officer (contacts on page 8).

If you want to burn grass, paddocks and bush during the Restricted Burning Period, you will need a permit to burn. To apply for a permit call your local Bush Fire Control Officer at least 72 hours before your proposed burn. They will assess your proposed burn and issue a written permit (if approved).

Burning permits are only valid for the day or days written on the permit. If you have been refused a permit, you can't reapply for the same burn. Appeals to a refusal can only be lodged to the Chief Bush Fire Control Officer by emailing shire@harvey.wa.gov.au.

The permit holder must strictly adhere to the following conditions and any special conditions imposed by the Bush Fire Control Officer:

a. Register their burn with DFES Communications Centre on 9395 9209.

b. Contact the Shire Administration Centre no later than 24 hours prior to the day when the proposed burn is to take place. Weekend burning must be notified by Friday at 4pm on 9729 0300.

c. Contact the owner and/or occupier of adjoining land.

d. The nearest Department of Biodiversity Conservation and Attractions (DBCA), if the land is situated within 3 km of State Forest Land, National Parks, Nature Reserve and other DBCA lands on 9735 1988.

e. Period of notice to neighbours prior to burning cannot be more than 28 days or less than four days, although lesser notice may be determined by the mutual agreement of all neighbours.

f. Burning under permit is not permitted during the Restricted Burning period on Sundays and Public Holidays.

Note: The lighting of all fires whether they are in or out of the restricted burning period is the sole responsibility of the person lighting the fire and due caution should be observed, including taking into account adverse weather conditions.

Key Contacts

Chief Bush Fire Control Officer
Michael Papalia – 0439 922 606

Deputy Chief Bush Fire Control Officer (South)
Wayne Jackson – 0418 940 929

Deputy Chief Bush Fire Control Officer (North)
Vaughn Byrd – 0404 800 302

Bush Fire Control Officers

Contact a Bush Fire Control Officer between the hours of 9am and 5pm Monday to Friday. Please note, 72 hours notice is required prior to burning.

Michael Papalia	Australind Townsite	0439 922 606
Peter Simpson	Leschenault, Australind, Parkfield and Wellesley	0419 989 660
Peter Simpson	Binningup	0419 989 660
Wayne Jackson	Myalup	0418 940 929
Tracey Osborn	Yarloop	0457 088 073
Kevin Prowse	Uduc	0418 921 811
Robert George	Brunswick Town, Roelands and Olive Hill	08 9726 1132 0417 173 553
Vaughn Byrd	Harvey townsite, Harvey Hills and Benger	0404 800 302
Jayden Marinelli	Cookernup	0402 175 047

Other contacts

Community Emergency Services Manager
08 9729 0383

Shire of Harvey
08 9729 0300

Volunteer Brigades

Binningup Volunteer Bush Fire Brigade	Dario Nandapi	0429 201 534
Brunswick Fire and Rescue Service	Colin Keys	0456 111 175
Cookernup Volunteer Bush Fire Brigade	Derek Everington	0448 197 723
Eaton/Australind Fire and Rescue Service	Matthew Stoltenbarg	0456 957 281
Harvey Fire and Rescue Service	Scott Britza	0409 015 047
Harvey Hills Volunteer Bush Fire Brigade	Doug Buist	0450 302 511
Leshenault Volunteer Bush Fire Brigade	Michael Papalia	0439 922 606
Myalup Volunteer Bush Fire Brigade	Paul Reynolds	0406 063 464
Olive Hills/Roelands Volunteer Bush Fire Brigade	Jeremy Gunson	0409 725 960
Uduc Volunteer Bush Fire Brigade	Andrew Mapstone	0428 292 609
Yarloop Volunteer Bush Fire Brigade	Matthew Anzellino	0437 411 614

Hazard Reduction Guidelines

Preparing your property

Preparing for fires is essential to living in our fire prone landscape. Having a plan is the primary step to ensuring the survivability of your property and the welfare of you and your family, including pets and livestock.

Ensure that all firebreaks (if this is a requirement for your property) are maintained and totally clear of all flammable material either living or dead and are maintained in this state for the entire compliance period. Cleared hardstand areas and areas maintained in a green state may be considered acceptable as a firebreak.

20m A 20 m circle is recommended by DFES.

- Clear all rubbish, long dry grass, bark and material that may catch fire.
- Cut long grass to a height of 5 cm.
- Prune lower branches up to 2 m off the ground to stop a ground fire spreading into the canopy of the trees.
- Create and maintain a minimum 2 m gap between your house and tree branches. Do not pile wood against or near your house.
- Rake up leaves and other combustible materials from under trees.
- Keep roof gutters and valleys clear of leaves and bark.
- Hoses should be long enough to reach all parts of your house and use metal fittings as these are less likely to melt.
- Building Envelopes have been allocated to all lots within Special Residential and some Special Rural areas. Clearing living vegetation outside the confines of the Building Envelope requires approval from the Shire.
- Make sure you have ample water and another power source as you may lose power in a fire. You may need a petrol/diesel generator powered pump to draw water from an alternative source, such as dams, pools or water tanks.
- Have a bush fire survival plan and kit ready visit firechat.wa.gov.au to prepare a plan,by having a five-minute fire chat with your family .
- Check your home and contents insurance cover is adequate.

Stay Informed

REPORT ALL FIRES TO 000

Harvest and Vehicle Movement Bans

For all up to date information regarding Harvest and Vehicle Movement Bans, please tune in to the following:

ABC Local Radio
There will be designated tune-in times for listeners to hear harvest bans:

Weekdays	10.05am, 12.35pm and 2.05pm (1.05pm in Perth metro area)
Weekends	12.35pm and 2.05pm

Total Fire Bans

Information Line **1800 709 355**

dfes.wa.gov.au

emergency.wa.gov.au

ABC (684/720AM) Local Radio

DFES Emergency Info Line

133 337

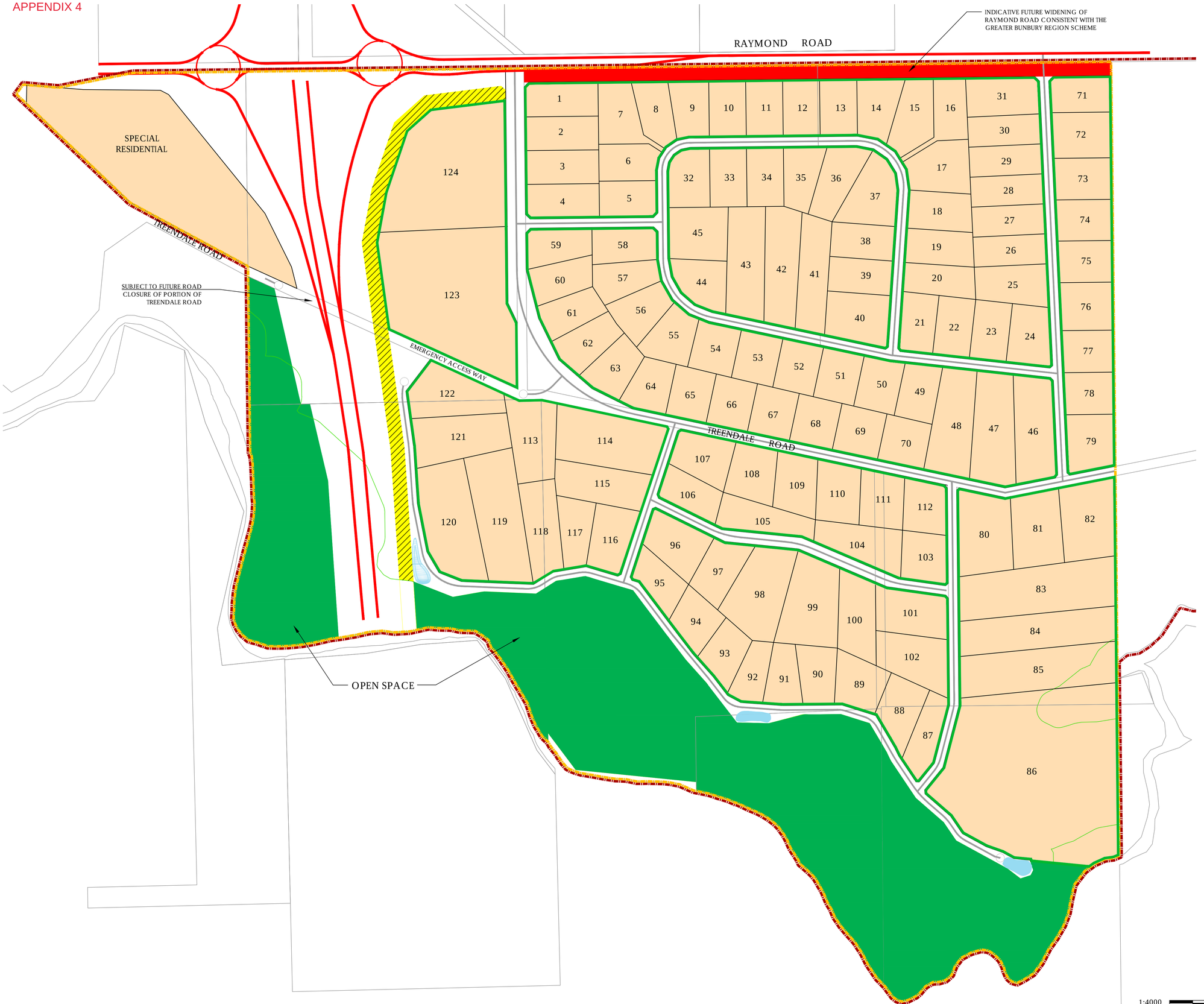
Follow DFES on Twitter and Facebook or listen to ABC Radio South West WA

SHIRE OF HARVEY

harvey.wa.gov.au
102 Uduc Road, Harvey, WA 6220
PO Box 500 Harvey, WA 6220

@shireofharvey Shire of Harvey

APPENDIX 4



LEGEND

LOCAL SCHEME RESERVES

- PUBLIC PURPOSE - NOISE BUND

ZONES

- RURAL RESIDENTIAL

RESERVED ROADS

- PRIMARY REGIONAL ROADS

OTHER

- ACCESS ROAD
- STRUCTURE PLAN BOUNDARY
- CONCEPT PLAN BOUNDARY
- EXISTING CADASTRE
- DRAINAGE BASIN

1:4000
At A1

0 50m 100 150 200 250 300 350 400

TREENDALE POLICY AREA 3B
CONCEPT PLAN
STAGE ONE

tecon AUSTRALIA

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WESTERN AUSTRALIA
NORTHERN TERRITORY

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APPENDIX 5

TECON AUSTRALIA

TREENDALE SOUTH STRUCTURE PLAN

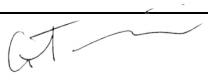
ENGINEERING SERVICING REPORT

AUGUST 2020

WML
Consulting Engineers

Distribution Record

Revision	Reviewed By	Date Issued	Purpose of Issue	Issued To
A	L Rusconi	28/8/2020	Client Review	Tecon Australia
B	L Rusconi	3/9/2020	Client Amendments	Tecon Australia

Prepared by:	G Tomasini
Signed:	
Date:	3/9/2020
WML Name:	9159-C-Engineering Service Report
WML Project No:	9159

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Contents

1. PROJECT SUMMARY

WML have been engaged to investigate the serviceability of the Treendale South development area shown below. The site is in the locality of Roelands under the jurisdiction of the Shire of Harvey.

The below figure taken from the 1996 Treendale Structure plan shows the location of the proposed development in detail. The development area is bounded by the proposed Bunbury Outer Ring Road (BORR) to the west, Raymond Road to the north, Treendale Road to the east and the Collie River to the south.

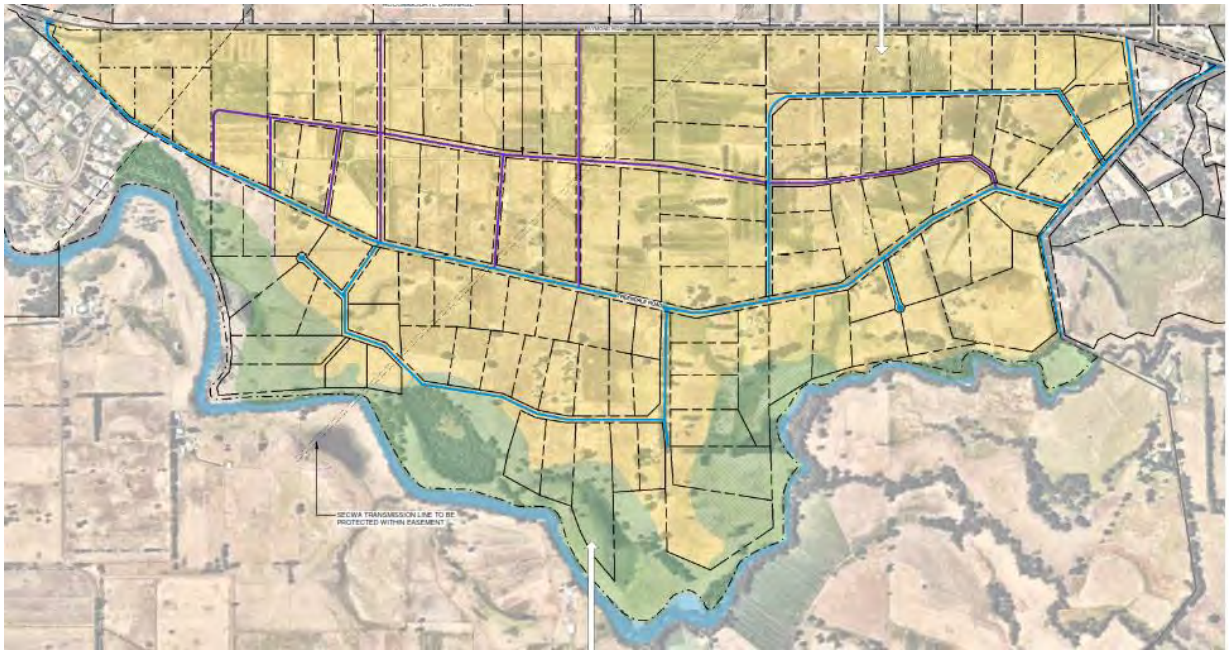


Figure 1: Excerpt from 1996 Treendale Structure Plan Policy Area 3B

2. LGA AND PLANNING INFORMATION

The development falls on two different zonal areas according to the Shire of Harvey's Town Planning Scheme Map No. 3. The land to the north of Treendale Road is zoned as "Intensive Farming" while the land to the south is zoned as "General Farming". Note that in the figure below the area to the west is not shown as zoned, this is due to this area being part of Town Planning Scheme Map No. 328 for Roelands Locality South. The zones to the north and south of Treendale Road are the same within both maps.

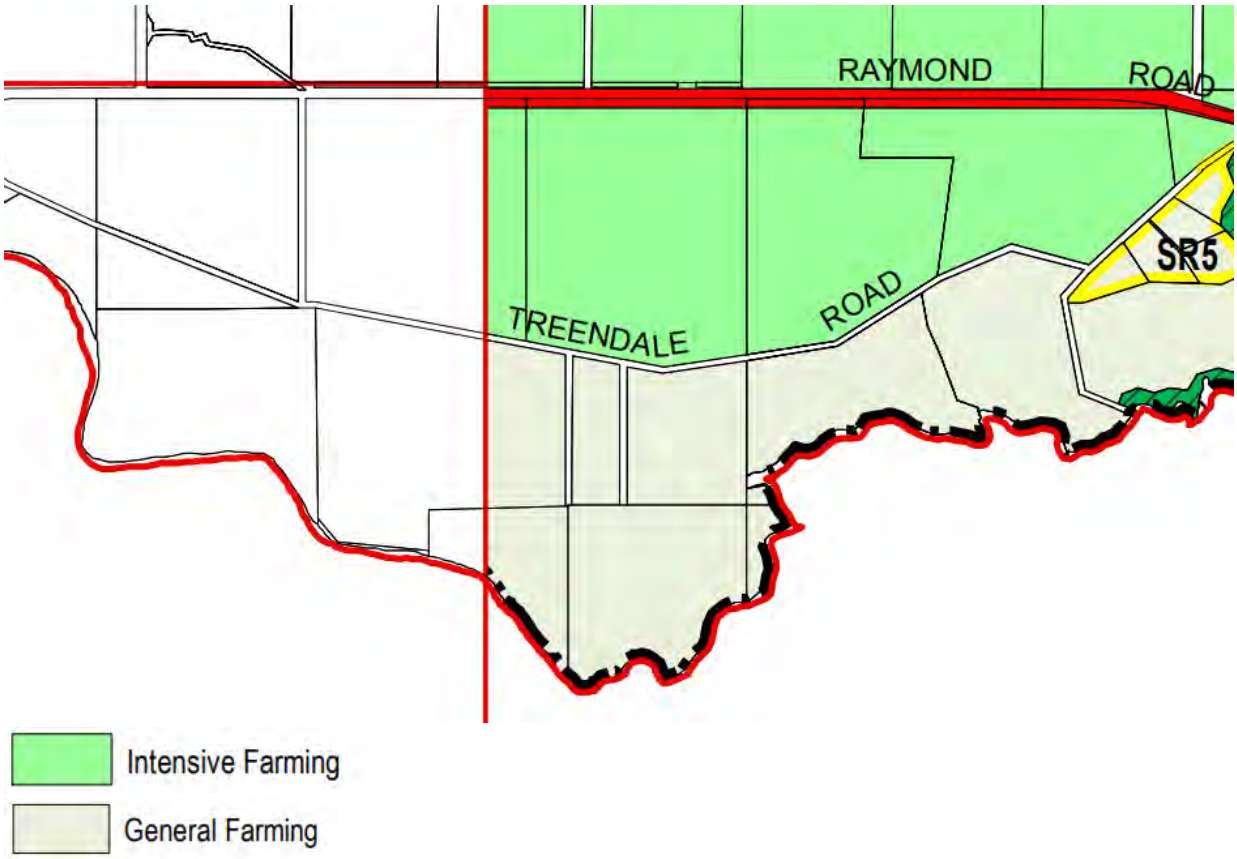


Figure 2: Shire of Harvey Planning Scheme Zones

3. GEOTECHNICAL AND HYDROLOGY

3.1 EXISTING SITE SUMMARY

The development area generally slopes and undulates towards the Collie River to the south with steeper grades found in close proximity to the River and the oxbow lakes. The 1:50,000 scale Geological map "Bunbury-Burekup" place the site predominantly on Guildford Formation comprising mainly alluvial sandy clays. Areas in close proximity to the Collie River are Alluvium associated with older river terraces. The below figure shows the proposed development outline and the various soil types that are mapped within the area.

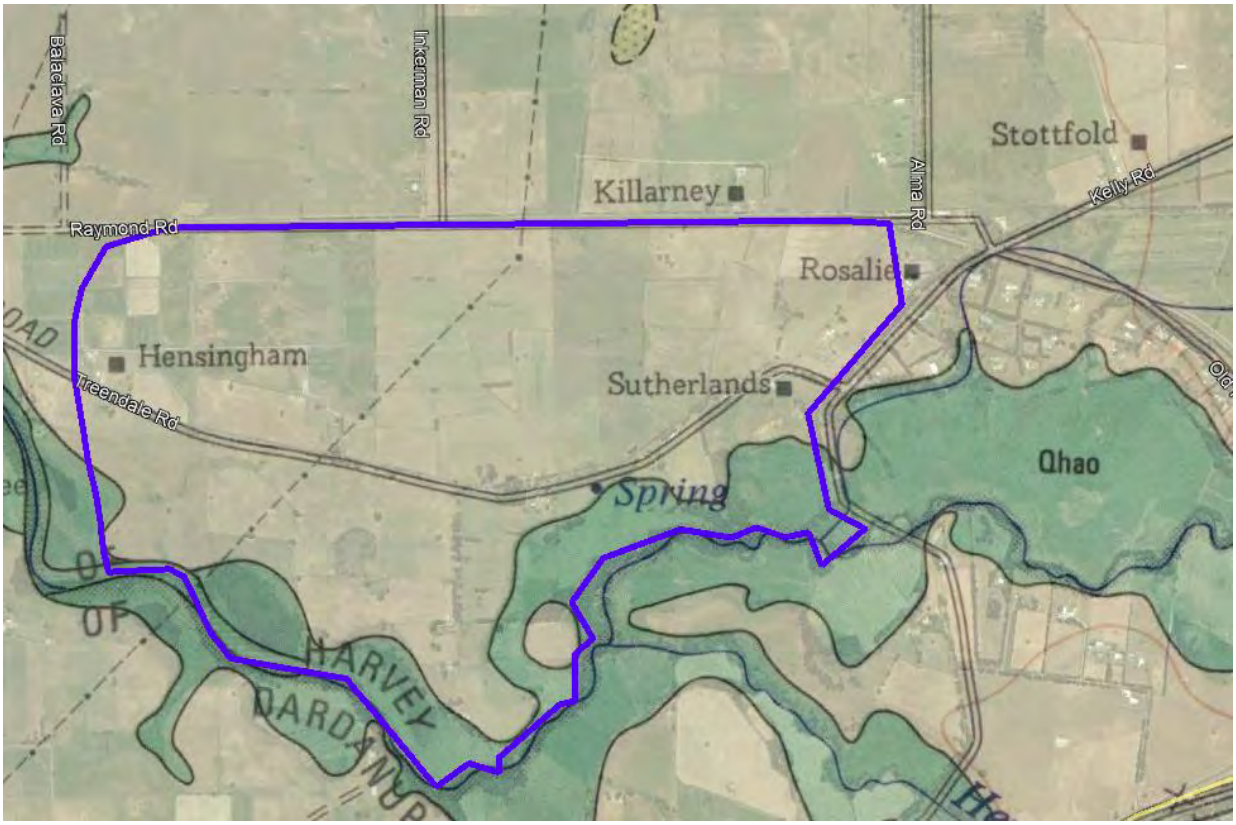


Figure 3: 1:50,000 scale geological map excerpt of development area

A suite of test pits was undertaken as part of an investigation undertaken by Cardno in 2006 which specifically looked at the lots to the South of Treendale Road. These test pits were generally consistent with the soils types shown above. Further geotechnical investigation may be required within the lots between Treendale and Raymond Roads to confirm material consistency within this area of the development also.

3.2 GROUNDWATER

Groundwater was not encountered in any of the test pits undertaken during the 2006 investigation which suggests that the water table is below the 2-3m depth to which the test pits were undertaken. The soils found over the site are generally low permeability clays and as such surface inundation and water logging may be an issue in areas where surface water is unable to drain freely.

Based on aerial imagery, known contours and anecdotal evidence the lower lying areas are susceptible to waterlogging and are unlikely to be able to carry construction traffic during winter months. Engineered solutions may be required to ensure drainage of the existing surface is maintained or improved beneath any development earthworks or construction.

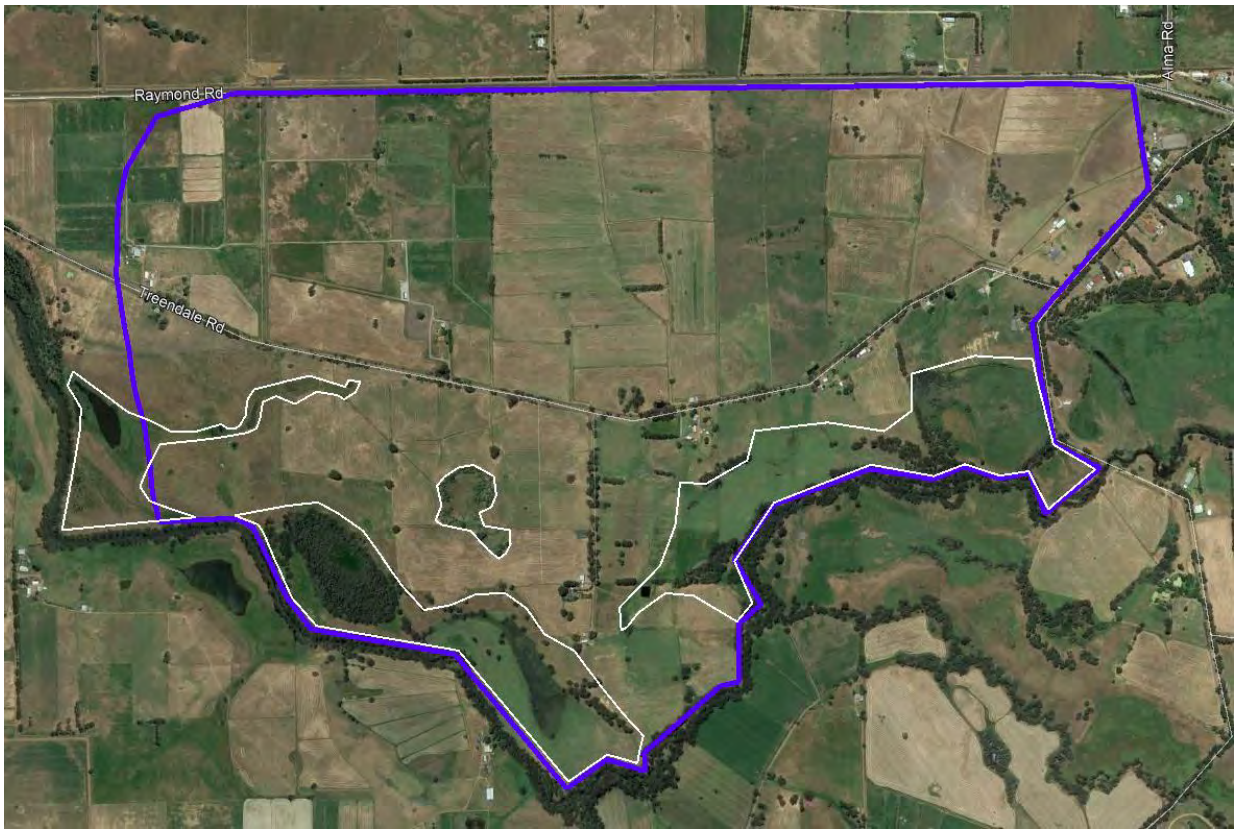


Figure 4: Areas susceptible to waterlogging

3.3 ACID SULPHATE SOILS

Investigation into the development site using the Acid Sulphate Risk Map shows that the site is generally a moderate to low risk of ASS occurring. These areas are shown as yellow in the below figure below. The areas in close proximity to the Collie River are classed as a high to moderate risk of ASS occurring.

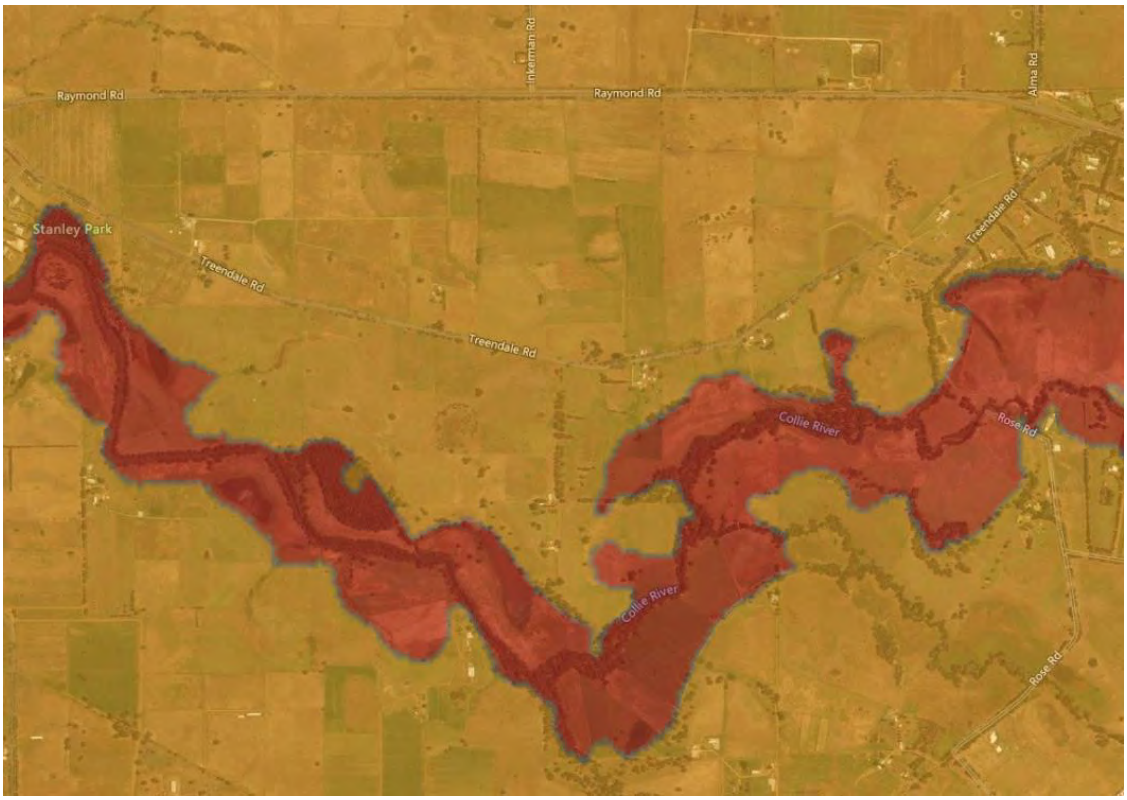


Figure 5: Areas susceptible to waterlogging

A specific ASS investigation and development of an ASS management plan will likely be required for the development. The extent and cost implications of this will depend of the earthworks for the development and extent and depth of any excavations required.

4. ROAD NETWORK SUMMARY

The proposed access to the development will be from Raymond Road. This is a Main Roads WA (MRWA) owned asset and as such the new access intersection will require their approval. The proposed intersection is currently located in close proximity to the BORR grade separated interchange with Raymond Road. The location will likely interact with the entry/exit legs which may cause approval issues. Should the intersection be constructed prior to the BORR then it may be at risk of being made redundant or turned into a left turn only intersection. It may be prudent at this early stage to move the intersection further to the east and redesign the internal road structure to suit.

The existing Treendale Road will form a major part of the development access. The proposed BORR will cut off access to the Western end of Treendale Road from within the development when constructed. The internal roads including Treendale are under the jurisdiction of the Shire of Harvey and any proposed road cross section will require their approval.

Typically for residential roads the Shire of Harvey would require a 6m wide 25mm AC7 asphalt sealed surface with kerbing. A typical cross section is shown in the figure below.

From the geotechnical report undertaken by Cardno in 2006 there is clayey material close to the surface and as such an improved subgrade layer of granular, free draining material may be required within the development. The use of subsoil drainage may also be required. These requirements will be further clarified during the detailed design phase.

Due to the large lots and rural setting it is not anticipated that the Shire of Harvey is going to require footpaths to be installed within the proposed development. This will need to be confirmed with the Shire in the detailed design phase.

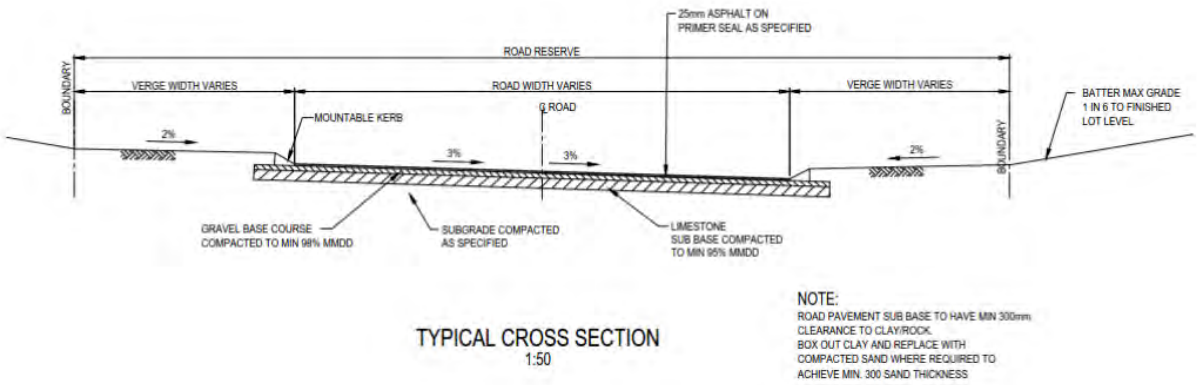


Figure 6: Typical Road Cross Section

5. STORMWATER MANAGEMENT

On site stormwater management will be required within the development. The most logical drainage strategy for the development is to drain all stormwater towards the Collie River to the south and to have any water retention structures located within the lower areas in close proximity to the river. A basic drainage plan showing drainage direction and possible retention basins is shown below.

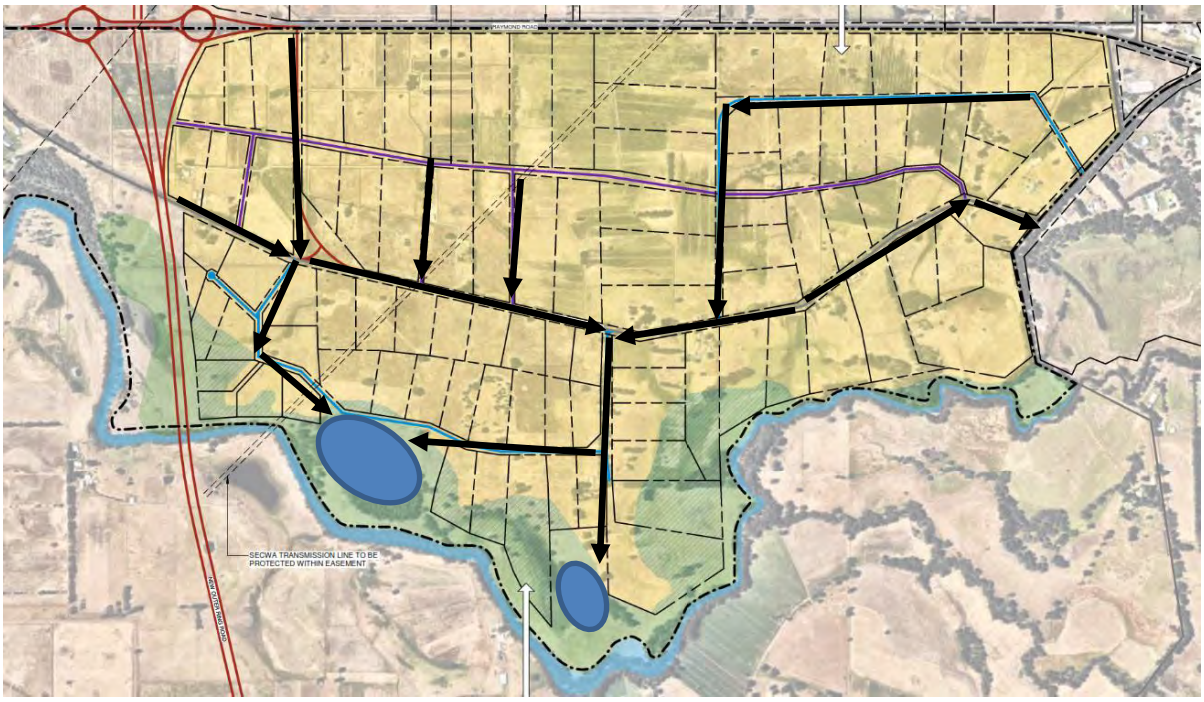


Figure 7: Concept Drainage Plan

The detailed stormwater plan will require development once a site feature survey has been undertaken and flow directions can be accurately determined

6. SITE EARTHWORKS REQUIREMENTS

With the large lots that are proposed within the development no bulk earthworks or filling is expected.

7. SERVICES

The below outlines existing services within the immediate area along with likely service requirements for the development.

7.1 SEWER

There is currently no reticulated sewer within the area of the proposed development. Given the proposed larger lots it is not anticipated that a reticulated sewer system will be required. Rather, on-site sewer units are expected on each individual lot.

7.2 WATER

According to Water Corporation's Esinet system the nearest viable connection is located at the intersection of Treendale and Ranson Drive. The 150mm diameter main will require to be checked for capacity to service the proposed lots as it runs the length of Ranson Drive servicing lots within Meadow Landings.

Should the 150mm not have the capacity, the developer will likely be required at their own cost to extend the 200mm main located at the intersection of Raymond Road and Ranson Drive to the development to allow for water services to the lots.

Harvey Water owned irrigation channels are present along Treendale Road. These channels are also connected to channels within the local privately owned farmland and work to irrigate and drain the land. It is understood by WML that Harvey water is currently preparing to pipe its entire irrigation system. As such, development within this area that will interact with the irrigation channel will require approval with their proposed infill project.

7.3 POWER

The Western Power planning tools indicate that there is insufficient capacity within the development area but there is sufficient capacity within Meadow Landings to service the development. Multiple transformers will be required through the site, these will be required progressively as stages of development are released.

Power services will require extension from existing power mains located within Meadow Landing. These will require extension through Treendale Road to the development. Western Power may require two power extensions to maintain a ring main system for the development.

Figure 8: Power Connection Locations

There are existing overhead lines that traverse the site that are likely to have to be relocated to allow development of the land. This will need to be funded by the developer and are likely to be done on a staged basis.

7.4 TELECOMMUNICATIONS

Communications services along Raymond Road are insufficient to service the new development and as such existing communications services within Meadow Landing will require extension to the development along Treendale Road. This cable will require installation which should be achievable on a staged basis.

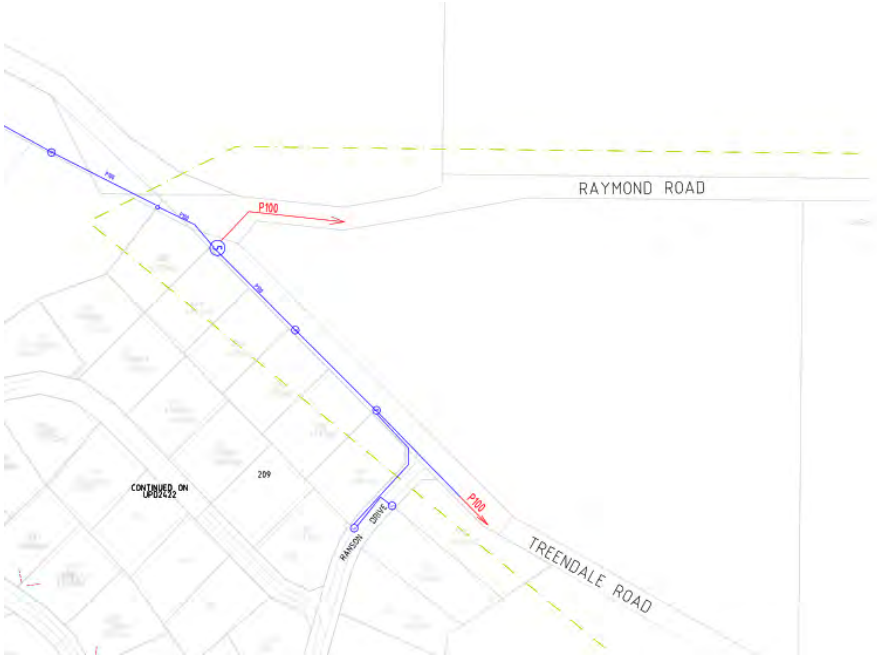


Figure 9: Communications Connection Locations

7.5 GAS

There is currently no mains gas service accessible within the area. It is not anticipated that mains gas will be required as part of development conditions.

8. SUMMARY

The structure plan area identified in this report is capable of being serviced by the essential infrastructure required for residential development. Some headworks extensions will be required for water, power and communications from Raymond and Treendale Road.

Appendix 6 - Treendale Structure plan policy area 3B Original Version

WESTERN AUSTRALIAN PLANNING COMMISSION ENDORSEMENT - 14th FEBRUARY 1996

COUNCIL IS ADVISED THAT THE COMMISSION HAS RESOLVED TO ENDORSE THE TREENDALE STRUCTURE PLAN FOR POLICY AREA 3B AS A GUIDE TO FUTURE DEVELOPMENT OF THE SUBJECT AREA, SUBJECT TO THE FOLLOWING MODIFICATIONS BEING CARRIED OUT BY COUNCIL -

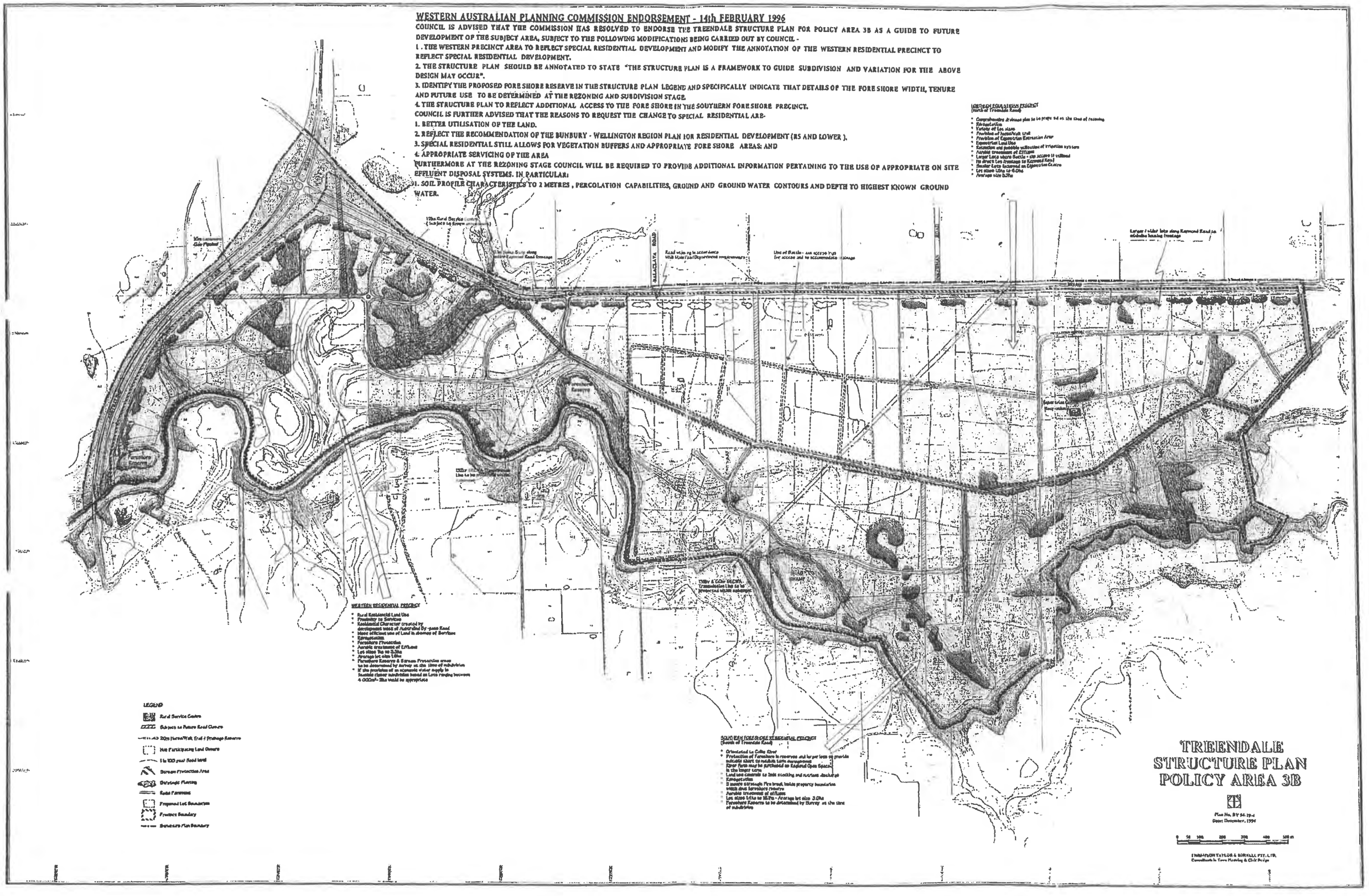
1. THE WESTERN PRECINCT AREA TO REFLECT SPECIAL RESIDENTIAL DEVELOPMENT AND MODIFY THE ANNOTATION OF THE WESTERN RESIDENTIAL PRECINCT TO REFLECT SPECIAL RESIDENTIAL DEVELOPMENT.
2. THE STRUCTURE PLAN SHOULD BE ANNOTATED TO STATE "THE STRUCTURE PLAN IS A FRAMEWORK TO GUIDE SUBDIVISION AND VARIATION FOR THE ABOVE DESIGN MAY OCCUR".
3. IDENTIFY THE PROPOSED FORE SHORE RESERVE IN THE STRUCTURE PLAN LEGEND AND SPECIFICALLY INDICATE THAT DETAILS OF THE FORE SHORE WIDTH, TENURE AND FUTURE USE TO BE DETERMINED AT THE REZONING AND SUBDIVISION STAGE.
4. THE STRUCTURE PLAN TO REFLECT ADDITIONAL ACCESS TO THE FORE SHORE IN THE SOUTHERN FORE SHORE PRECINCT.

COUNCIL IS FURTHER ADVISED THAT THE REASONS TO REQUEST THE CHANGE TO SPECIAL RESIDENTIAL ARE-

1. BETTER UTILISATION OF THE LAND.
2. REFLECT THE RECOMMENDATION OF THE BUNBURY - WELLINGTON REGION PLAN FOR RESIDENTIAL DEVELOPMENT (R5 AND LOWER).
3. SPECIAL RESIDENTIAL STILL ALLOWS FOR VEGETATION BUFFERS AND APPROPRIATE FORE SHORE AREAS: AND
4. APPROPRIATE SERVICING OF THE AREA

FURTHERMORE AT THE REZONING STAGE COUNCIL WILL BE REQUIRED TO PROVIDE ADDITIONAL INFORMATION PERTAINING TO THE USE OF APPROPRIATE ON SITE EFFLUENT DISPOSAL SYSTEMS. IN PARTICULAR:

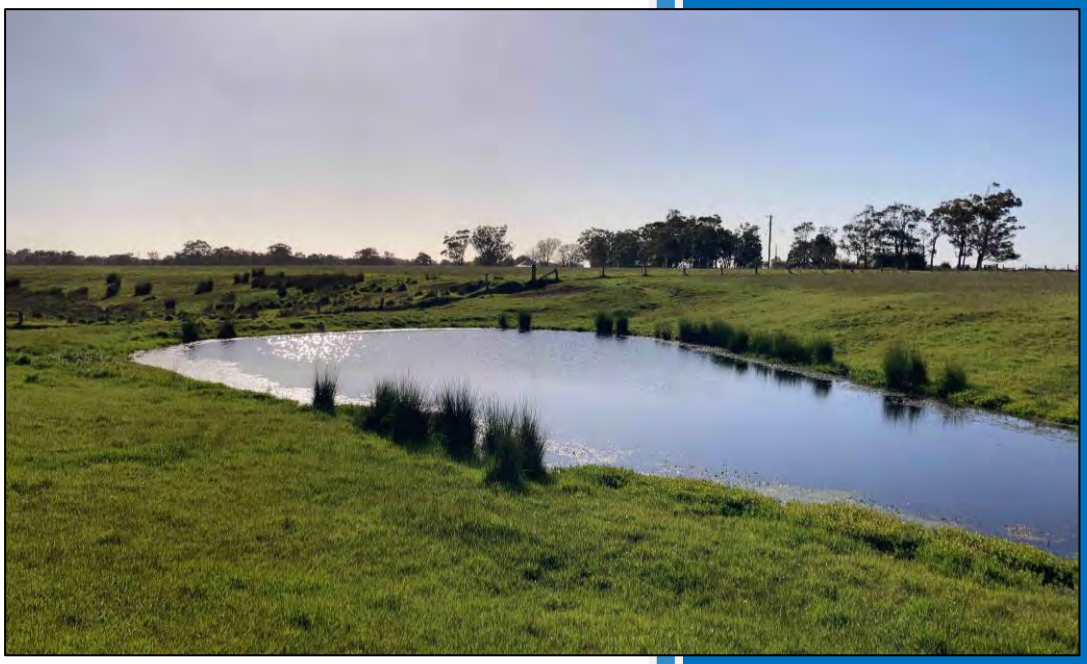
(1. SOIL PROFILE CHARACTERISTICS TO 2 METRES , PERCOLATION CAPABILITIES, GROUND AND GROUND WATER CONTOURS AND DEPTH TO HIGHEST KNOWN GROUND WATER.



APPENDIX 7

Treendale Structure Plan
Area 3B, Roelands WA

Local Water Management Strategy



Bio Diverse Solutions

02/08/22

DOCUMENT CONTROL

Title: Local Water Management Strategy – Treendale Structure Plan Area 3B, Roelands WA

Author (s): Chiquita Cramer

Reviewer (s): Mary Holt and Kathryn Kinnear

Job No.: MSC0285-003

Client: Tecon Australia

REVISION RECORD

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Draft 17/02/22	Internal technical review	C. Cramer	K. Kinnear	17/02/2022
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Final 22/02/22	Final report issued to client	C. Cramer	-	22/02/2022
Draft 01/08/22	Submitted to client for review	C. Cramer	K. Kinnear	01/08/2022
Final 02/08/22	Final report issued to client	C. Cramer	-	02/08/2022

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1 Introduction

1.1 Background

Treendale Structure Plan Area 3B Local Water Management Strategy (LWMS) has been prepared by Bio Diverse Solutions on behalf of Tecon Australia (planners and surveyors) to support and guide an amendment to the Local Structure Plan and subsequent subdivision of the site.

The LWMS provides the framework for the application of total water cycle management to the proposed urban structure. This is consistent with the Department of Water and Environmental Regulation (DWER) principles of Water Sensitive Urban Design (WSUD) described in the Stormwater Management Manual (DoW, 2007).

1.2 Key Design Principles and Objectives

The LWMS employs the following key documents to define its content, key principles and objectives:

- Stormwater Management Manual for Western Australia (DoW, 2007).
- Better Urban Water Management (WAPC, 2008).

A summary of the key design principles and objectives from these documents is summarised below and provided in Table 1.

1.2.1 Stormwater Management Manual (DoW 2007)

The Department of Water (DoW) (now Department of Water and Environmental Regulation (DWER)) released *A Manual for Managing Urban Stormwater Quality in Western Australia* in 1998. The manual defines and practically describes Best Management Practices (BMP's) to reduce pollutant and nutrient inputs to stormwater drainage systems. The Manual also aims to provide guidelines for incorporating water sensitive design principles into urban planning and design, which would enable improved water quality from urban development.

The document was released to provide a guideline for best planning and management practices, and was intended for use by the DoW (now DWER), State and Local Government Authorities, and sectors of the urban development industry.

DoW completed a major review of the manual in consultation with a working group comprising of industry and government representatives. The revised manual was officially launched in August 2007.

DWER's current position on urban stormwater management in Western Australia is outlined in Chapter 2: *Understanding the Context of the Stormwater Management Manual for Western Australia* (DoW, 2007), which details the management objectives, principles and a stormwater delivery approach for WA. Principle objectives for managing urban water in WA are stated as:

- Water Quality: To maintain or improve the surface and groundwater quality within development areas relative to pre-development conditions.
- Water Quantity: To maintain the total water cycle balance within development areas relative to the pre-development conditions.
- Water Conservation: To maximise the reuse of stormwater.
- Ecosystem Health: To retain natural drainage systems and protect ecosystem health.
- Economic Viability: To implement stormwater systems that are economically viable in the long-term.
- Public Health: To minimise public risk, including risk of injury or loss of life to the community.
- Protection of Property: To protect the built environment from flooding and water logging.

- Social Values: To ensure that social aesthetic and cultural values are recognised and maintained when managing stormwater.
- Development: To ensure the delivery of best practice stormwater management through planning and development of high-quality developed areas in accordance with sustainability and precautionary principles.

1.2.2 Better Urban Water Management (WAPC, 2008)

The guideline document Better Urban Water Management (BUWM) (WAPC, 2008), focuses on the process of integration between land use and water planning. The document specifies the level of investigation and documentation required at various decision points in the planning process, rather than the provision of any specific design objectives and criteria for urban water management.

This LWMS complies with the BUWM process.

Table 1: Summary of design principles and objectives

Key Guiding Principles		
• Facilitate implementation of sustainable best practice urban water management. • Provide integration with planning processes and clarity for agencies involved with implementation. • To minimise public risk, including risk of injury or loss of life. • Protection of infrastructure and assets from flooding and inundation. • Encourage environmentally responsible development. • Facilitate adaptive management responses to the monitored outcomes of development.		
Category	**Key Design Principles & Objectives**	**LWMS Criteria**
Surface Water Management	• Minimise changes in hydrology to prevent impacts on receiving environments. • Manage water flows from major events to protect infrastructure and assets. • Apply the principles of WSUD. • Adopt nutrient load reduction design objectives for stormwater runoff. • Floodplain management and urban drainage. • Adopt treatment train approach.	• Post-development critical peak flows will be consistent with pre-development peak flow at the discharge point of each sub-catchment within the Subject Site up to the 1% AEP. • Roadside swales and drainage system designed to convey up to the 1% AEP for flood management and erosion control. • First 15mm of rainfall from storm events will be treated at source where possible. • Manage surface water flows from major events to protect infrastructure and assets from flooding and inundation.
Groundwater Management	• Manage groundwater levels to protect infrastructure and assets. • Maintain groundwater regimes for the protection of groundwater-dependent ecosystems. • Protect the value of groundwater resources. • Adopt nutrient load reduction design objectives for discharges to groundwater.	• Managing and minimising changes in groundwater levels and groundwater quality following development.
Monitoring and Implementation	• Adopt an adaptive management approach. • Maintain drainage and treatment structures.	• Design based on methodology in Stormwater Management Manual of adopting a treatment train including: • structural treatment measures (infiltration storages, plus bio-retention treatment structures). • Non-structural measures to reduce applied nutrient loads. • Maintain groundwater quality at pre-development levels (median winter concentrations) and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems.
Water Conservation	• Adopt drinking water consumption target. • Ensure that non-potable water supply systems deliver a net benefit to the community. • Ensure that non-potable water supply systems are designed as part of an integrated water supply.	• Aim to achieve the State Water Plan target for water use and reduce water use where possible. • Consider alternative fit for purpose water sources where appropriate and cost-effective.

1.3 Suitable Qualified Hydrologist

This LWMS has been prepared by Chiquita Cramer, who has 12 years of experience working as a hydrologist and hydrogeologist.

Chiquita Cramer has the following tertiary qualifications:

- Bachelor of Science in Natural Resource Management (University of Western Australia); and
- Graduate Certificate in Hydrogeology (University of Western Australia).

Chiquita worked as a hydrologist and senior hydrologist at JDA Consultant Hydrologists in Perth for 8 years. Her experience includes preparation of multiple local and urban water management strategies, hydrological and hydraulic investigations, surface water and groundwater monitoring reports and hydrogeological reports. Chiquita completed a Graduate Certificate in Hydrogeology and in 2017 joined Bio Diverse Solutions (BDS) to provide expertise in hydrology and hydrogeology to the company.

1.4 Location

The Subject Site is defined as a portion of or all of Lots 1, 2, 3, 121, 185, 246, 314, 878 and 3315 Treendale Road, Roelands WA within the Shire of Harvey. The site consists of ~215ha and is bound by Raymond Road to the north, the Collie River to the south and agricultural properties to the east and west. The future Bunbury Outer Ring Road (BORR) is proposed immediately west of the Subject Site. The location of the Subject Site is shown in Figure 1.

The Subject Site does not include the low-lying area and wetlands directly north of the Collie River, this area is addressed in the Wetland Management Plan (Bio Diverse Solutions, 2020) and no development or stormwater management is proposed in this area.

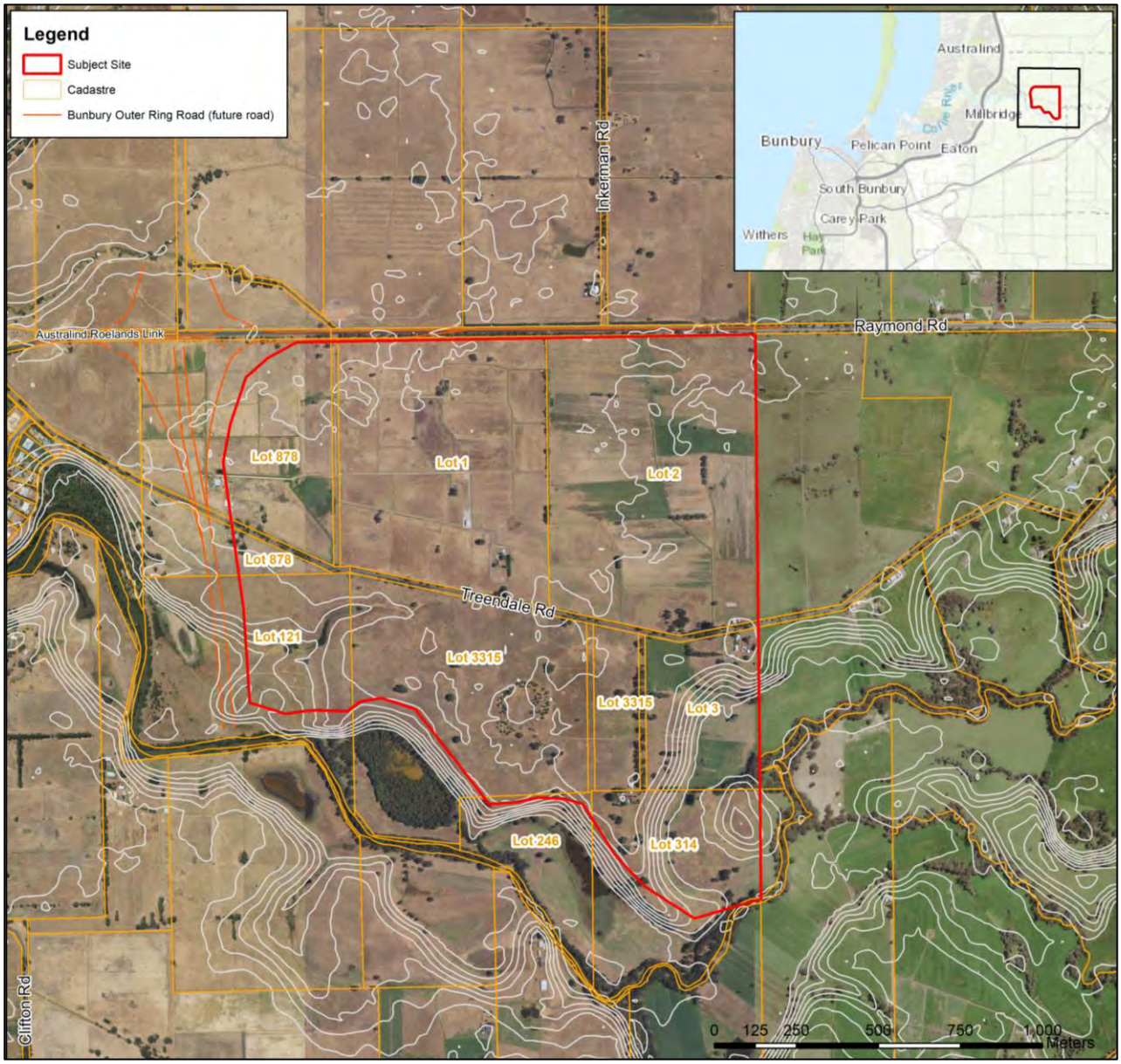


Figure 1: Location Plan

2 Proposed Development

The portion of the Subject Site north of Treendale Road is zoned as 'Intensive Farming' and to the south of Treendale Road is zoned as 'General Farming' according to the Shire of Harvey Local Planning Strategy No.1 (2020). It is proposed the Subject Site be rezoned to 'Special Residential' and subdivided into approximately 132 rural residential lots ranging in size from ~1.0ha to 13.3ha. The Stage 1 Subdivision Concept Plan (Tecon Australia, 2022) for the Subject Site is shown in Figure 2.

The Landholdings are within the 1996 Treendale Structure Plan (Policy Area 3B – 1996 Structure Plan) which was endorsed by the WAPC in February 1996 and applies to a number of properties between Raymond Road and the Collie River. The Landholdings have been designated under the 1996 Structure Plan for future rural residential development.

The Department of Planning, Lands and Heritage (DPLH) has considered the status of the 1996 Structure Plan and has determined that the Plan has full legal effect as a document to be given due regard in any decision making.

In noting the status of the 1996 Structure Plan and the advice from DPLH that the 1996 structure plan has full legal affect there is still a need to amend the document to address the implications of the Bunbury Outer Ring Road (BORR) as well as comprehensively addressing environmental and engineering servicing considerations.

The Amended Concept Plan will provide the framework for the coordinated provision and arrangement of the land uses, subdivision and development. It will also inform the provision of a transport network, public open space, public utilities, development standards, community infrastructure and urban water management.

Key elements of the subdivision relating to water management include:

- Use of bio-retention treatment storages/swales for detention and treatment of stormwater runoff from internal roads;
- Building finished levels will be a minimum 500 mm above 1% Average Exceedance Probability (AEP) top water levels in stormwater storage areas;
- Promotion of the use of local native plants for gardens, streetscaping and bio-retention storage systems. Any non-local species will be selected for drought tolerance and low fertiliser requirements; and
- Use of the local road network for storm water conveyance.

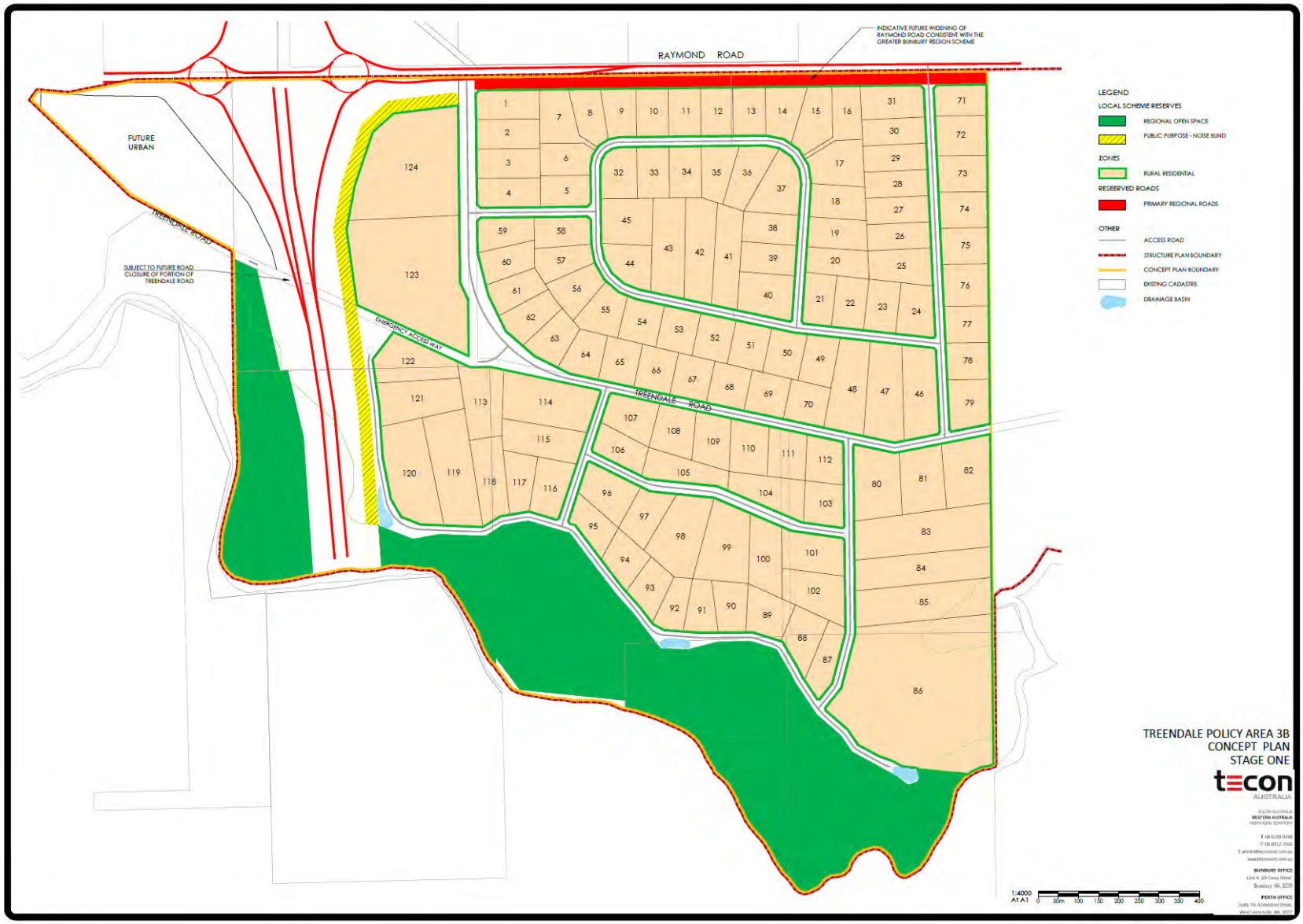


Figure 2: Concept Plan (Tecon Australia, 2022)

3 Pre-development Environment

3.1 Existing Land Use

The Subject Site currently consists of agricultural land used for mixed cropping and livestock. Historically the Subject Site was used for dairy farming with an old dairy facility present in the southeast of the site and an open channel distribution network historically used for dairy farming via flood irrigation techniques from the Wellington Dam present in the north. There are three residential dwellings on the Subject Site, two in the southeast of the site and one in the central north. The land immediately to the west of the Subject Site is currently being developed into the Bunbury Outer Ring Road. The Collie River and adjacent wetlands/low lying areas are directly south of the Subject Site.

Photo 1: View to the south of the Collie River located south of the Subject Site.

Photo 2: View to the southeast of low-lying area and wetlands to the south of the Subject Site.

Photo 3: View to the south of open channel distribution network located in the north. The drains were historically used for irrigation via flood irrigation techniques. The drains at the time of the site investigation were filled with groundwater.

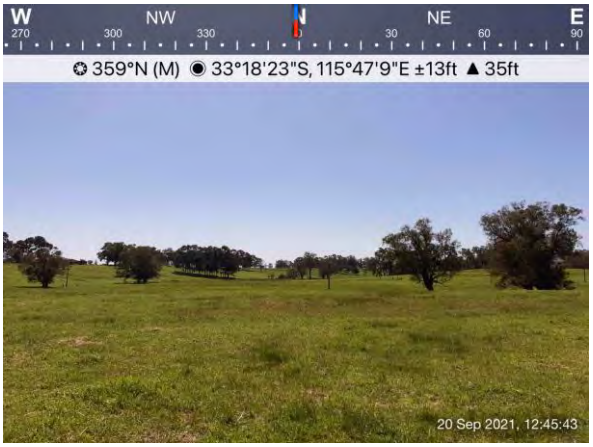


Photo 4: View to the north from the southeast of the site showing agricultural land evident across the site.

3.2 Topography

The majority of the Subject Site is relatively flat and lies between 14 to 16m AHD. The southern portion of the site slopes down towards the Collie River, with the lowest point being 4m AHD in the southeast of the site. Topographic contours (2 metre) are shown in Figure 3.

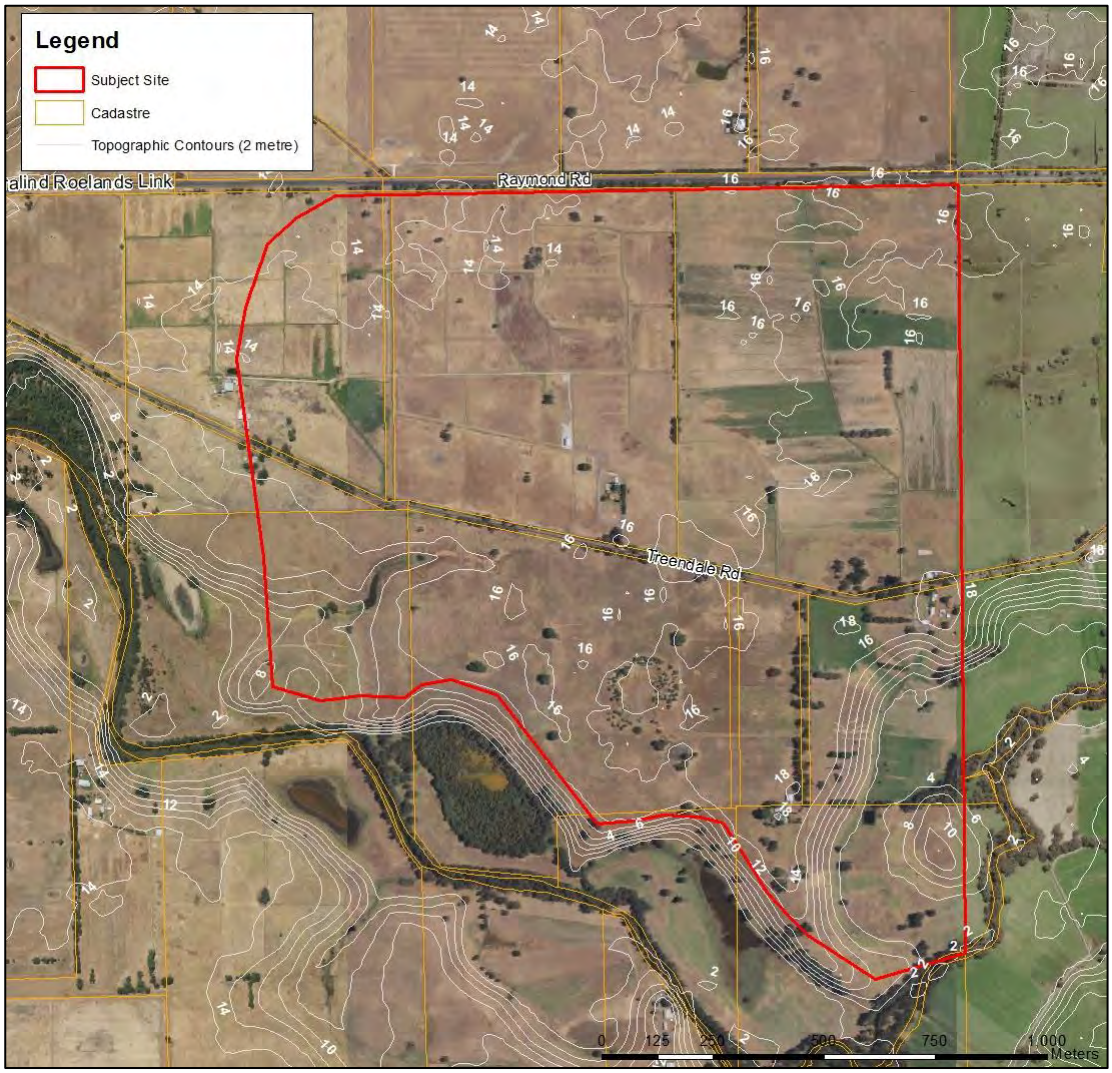


Figure 3: Topography

3.3 Climate

The Roelands area is characterised by a Mediterranean climate with warm dry summers and cool wet winters. Rainfall data is from the nearby Bureau of Meteorology (BoM, 2021) Burekup Station (Site No. 9710).

The long-term average annual rainfall is 896mm (1905 to 2020). This average has decreased between 2000 to present, to an average annual rainfall of 807mm, reflecting a 10% reduction compared to the long-term average, consistent with a general trend in the South West of WA.

The total rainfall distribution has also altered, with a reduction of average winter monthly rainfall, but no significant reduction in average summer monthly rainfall.

The average annual pan evaporation for the Roelands area is approximately 1400mm (Luke et al 1988).

3.4 Remnant Vegetation

The Subject Site predominantly consists of cleared agricultural land with some scattered remnant vegetation consisting of Marri and Jarrah trees and a patch of paperbark trees in the central south.

The Subject Site lies within the SWA2 – Swan Coastal Plain Interim Biogeographic Regionalisation for Australia (IBRA). The region is described as: '*The Swan Coastal Plain is a low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, Casuarina obesa on outwash*

plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland.'.

The vegetation has been mapped on a broad scale by J.S. Beard (Shepherd et al 2002) in the 1970's, where a system was devised for state-wide mapping and vegetation classification based on geographic, geological, soil, climate structure, life form and vegetation characteristics. A GIS search of J.S. Beard's vegetation classification places the Subject Site within two System and Vegetation Association (DPIRD, 2017a):

- **System Association Name**: Pinjarra (comprising most of the Subject Site)
- **Vegetation Association Number:** 968
- **Vegetation Description:** Jarrah, Marri and Wandoo *Eucalyptus marginata*, *Corymbia calophylla, E.* wandoo.

and

- **System Association Name**: Bassendean (northwest corner)
- **Vegetation Association Number:** 1000
- **Vegetation Description:** Woodland / Low woodland / Low forest or Woodland.

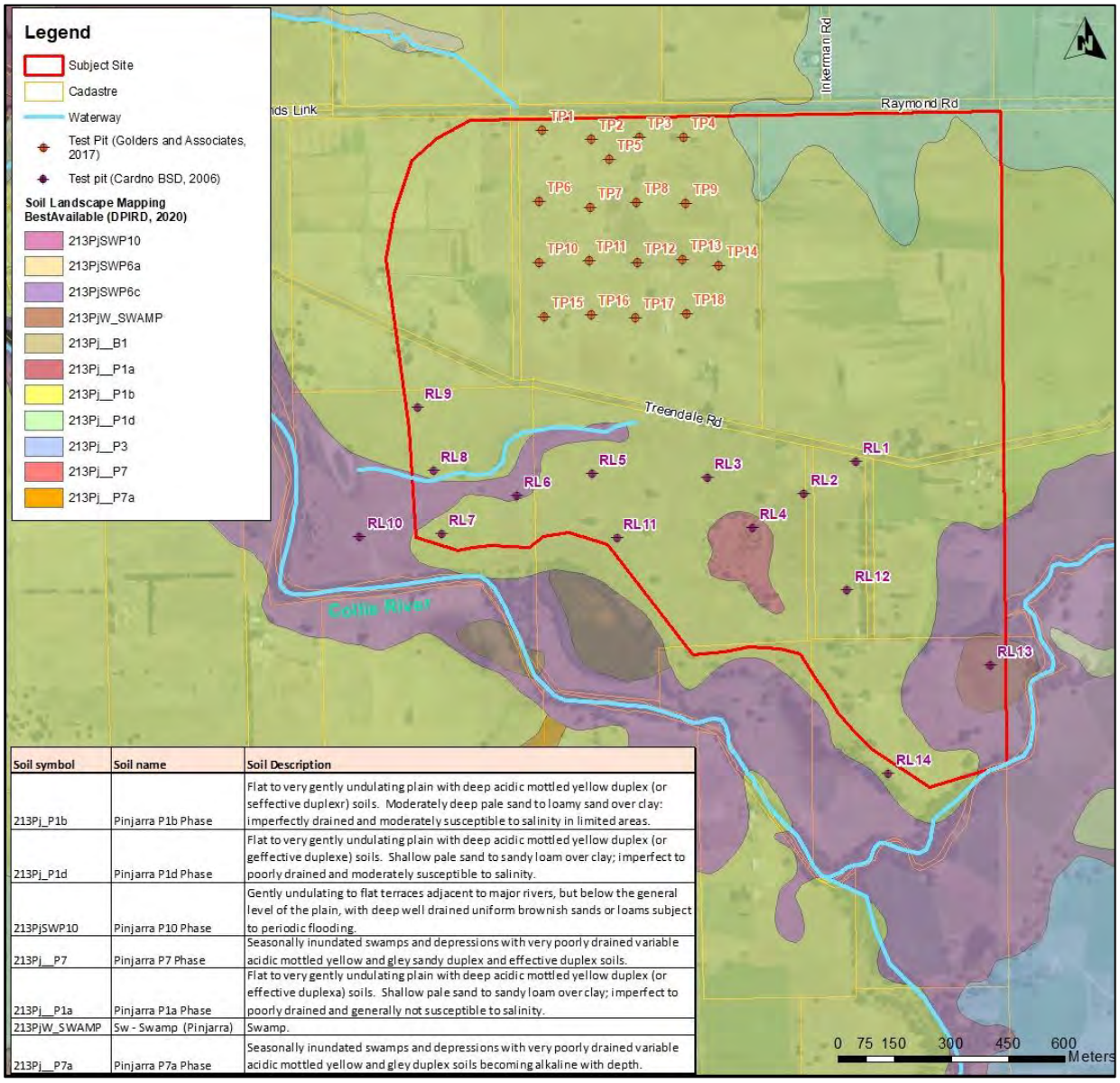
There are no Conservation Parks or Class "A" Reserves within the Subject Site or within the vicinity of the Subject Site.

3.5 Acid Sulphate Soils

Acid sulphate soils (ASS) are naturally occurring soils and sediments containing sulphide minerals, predominantly pyrite (an iron sulphide). When undisturbed below the water table, these soils are benign and not acidic (potential acid sulphate soils). However, if the soils are drained, excavated or exposed by lowering of the water table, the sulphides will react with oxygen to form sulphuric acid. ASS Risk Mapping indicates the Subject Site lies within an area of moderate to low risk of ASS occurring within 3 metres of natural soil surface (DWER, 2017). The area directly south of the Subject Site within the low lying flood plain areas have a high to moderate risk of ASS occurring within 3 metres of natural soil surface (DWER, 2017). These areas of moderate to high risk of ASS will not be disturbed as part of development works.

3.6 Geology and Soils

Soil mapping – Best Available (DPIRD, 2017b) shows the Subject Site lies within the Pinjarra System (213Pj). The system is described as "*Swan Coastal Plain from Perth to Capel. Poorly drained coastal plain with variable alluvial and aeolian soils. Variable vegetation includes Jarrah, marri, wandoo, paperbark sheoaks and rudis*". The Pinjarra Zone (213) is described as having "*Alluvial deposits (early Pleistocene to Recent) between the Bassendean Dunes Zone and the Darling Scarp, colluvial and shelf deposits adjacent to the Darling Scarp. Clayey to sandy alluvial soils with wet areas.*" (DPIRD, 2017b). The Subject Site is also located in several sub-systems of the Pinjarra System as defined by DPIRD (2017b). The sub-systems are shown and described in Figure 4.



Soil symbol	Soil name	Soil Description
213Pj_P1b	Pinjarra P1b Phase	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or seffective duplexr) soils. Moderately deep pale sand to loamy sand over clay: imperfectly drained and moderately susceptible to salinity in limited areas.
213Pj_P1d	Pinjarra P1d Phase	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or geffective duplexe) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and moderately susceptible to salinity.
213PjSWP10	Pinjarra P10 Phase	Gently undulating to flat terraces adjacent to major rivers, but below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding.
213Pj__P7	Pinjarra P7 Phase	Seasonally inundated swamps and depressions with very poorly drained variable acidic mottled yellow and gley sandy duplex and effective duplex soils.
213Pj__P1a	Pinjarra P1a Phase	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or effective duplexa) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity.
213PjW_SWAMP	Sw - Swamp (Pinjarra)	Swamp.
213Pj__P7a	Pinjarra P7a Phase	Seasonally inundated swamps and depressions with very poorly drained variable acidic mottled yellow and gley duplex soils becoming alkaline with depth.

Figure 4: Soil Mapping

Soil testing was conducted at the Subject Site in the area south of Treendale Road in 2006 by Cardno BSD as part of an Environmental Assessment and Land Capability Assessment for the area. The Environmental Assessment and Land Capability Assessment (Cardno BSD, 2006) report is included as Appendix A and the test pit locations are shown in Figure 4.

The investigation included the construction of 14 test pits and the soil types found at the site were found to consist of duplex soils with varying depths (0.2m – 0.7m) of pale quartz sand overlaying dense highly plastic clays in the northern portion of the investigation area. Within the southeast of the Subject Site soils were found to be red earths (to 1.3m) overlying hard packed yellow/orange and white/grey clay (RL13 and RL14, as shown in Figure 4). Soils types in the southern floodplain areas were described as red/brown loamy earth (1.2m – 2.7m) overlying mottled grey/brown, orange/yellow or red/orange clays.

The soil type underlying the 213Pj_P7 sub-system (Figure 4) as indicated by soil test pit RL4 (Cardno BSD, 2006) was found to consist of dry dense clay over cementitious quartz and laterite. Cardno BSD (2006) found this test pit location was difficult to excavate and soils here are considered to be completely impermeable.

Soil testing was also conducted on Lot 1 Treendale Road (Figure 1), to the north of Treendale Road, by Golder and Associates in 2017 as part of a Geotechnical Investigation. The investigation is included as Appendix B and the soil test pit locations are shown in Figure 4. The investigation included the construction of 18 test pits

to the depth of 1.3 to 2.5 metres. Based on the field investigation results, soils across the site are summarised by Golder and Associates (2017) as:

- Silty sand (topsoil): fine to medium grained, black, ~10-15% low plasticity fines, trace organics, loose to medium dense, moist to dry, extending from the ground surface to depths of between about 0.15 m and 0.2 m, overlying;
- Clayey sand: fine to medium grained, yellow, grey, low to medium plasticity, generally medium dense to dense, dry to moist, containing weakly to well cemented (laterised) zones, extending to depths of between 0.4 m and the maximum depth investigated of 2.5 m, overlying;
- Sandy clay: medium to high plasticity, fine to medium grained, grey with red and orange mottling, generally stiff to very stiff, containing weakly cemented zones, extending to the maximum depth investigated of 2.5 m.

Site soil testing was also conducted on the 20th and 21st of September 2021 by Bio Diverse Solutions under late winter conditions. Testing involved site soil analysis, photographic recording, logging of soil types, measuring of water table, infield infiltration testing and laboratory PRI testing. In total, 27 test holes were constructed to a varying depth up to 2m and left open for a minimum of 1 hour to identify any water table present. The soil logs for the site are included in Appendix C. Test hole locations are shown in Figure 5.

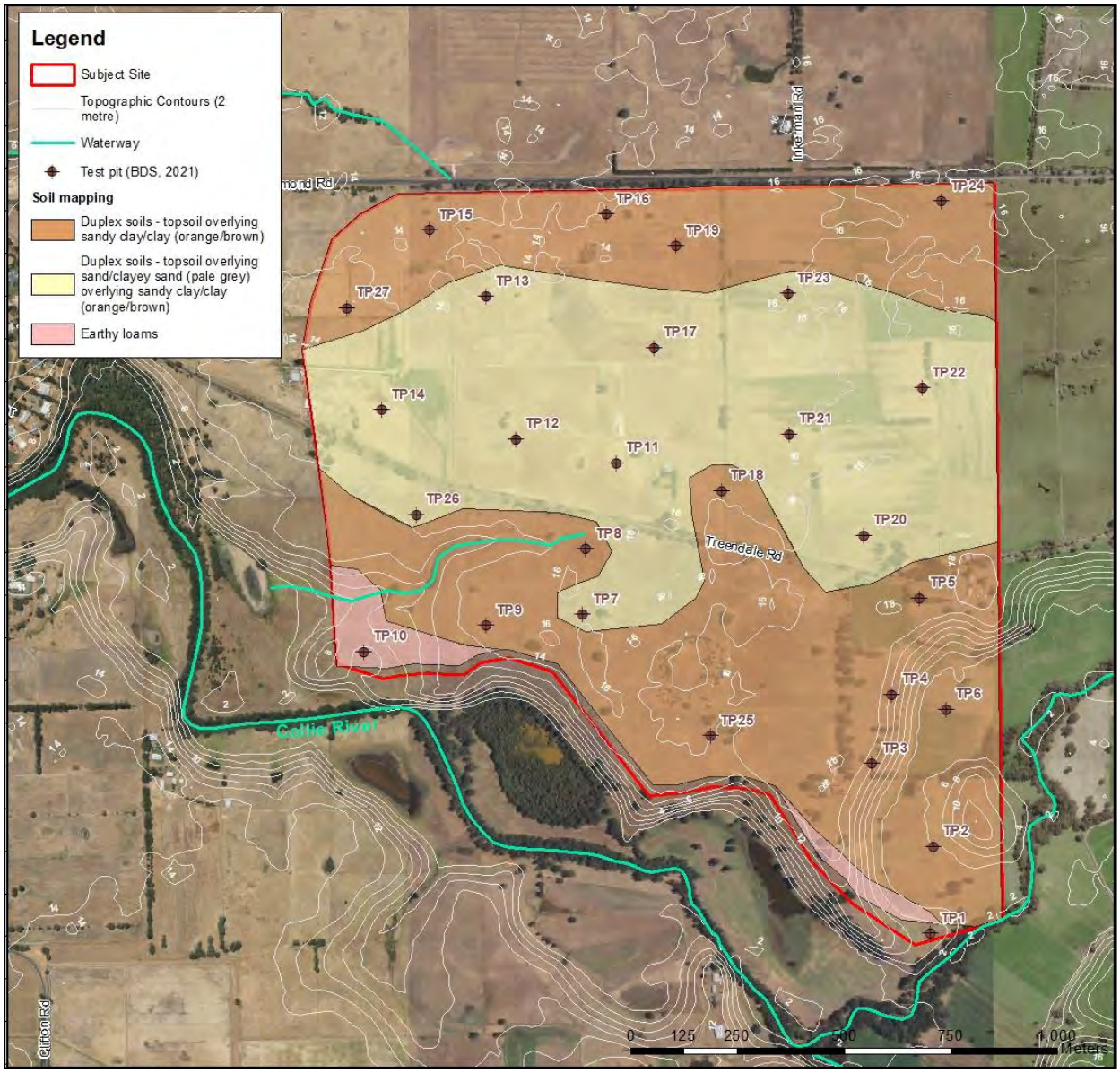


Figure 5: BDS Soil testing locations and mapping

The 27 test pits revealed that soils across the Subject Site varied somewhat with site and topography, however generally soils across the Subject Site comprised of duplex soils of varying depths of sand overlaying sandy clay. The general soil profile found across the site comprised of:

- Silty sand/loam (topsoil): fine grained, well sorted, dark grey/brown, moist to dry, extending from the ground surface to depths of between 0.2 m and 0.4 m, overlying;
- Sand/clayey sand: fine grained, well sorted, grey to light grey, moist to saturated, extending from beneath the topsoil to depths generally between 0.4 and 0.6m BGL (this layer was only present through the central portion of the Subject Site, refer to Figure 9), overlying;
- Sandy clay: fine grained sand, orange/brown. Plasticity usually transitioned from low to medium close to surface (up to 0.6m BGL) particularly where no sand layer was present to medium to high with depth

In addition to this soil type areas adjacent to the Collie River comprised of earthy loams, with soil profiles consisting of:

- Loam: fine grained, well sorted, dark brown, dry. Extending from the ground surface to depths of approximately 0.6m, overlying;
- Sandy clay loam: low plasticity, fine grained sand, red brown. Extending to the depth of hole at 2 metres.

Soil mapping based on soil testing (BDS, 2021) is presented in Figure 5.

3.6.1 Phosphorus Retention Index

Phosphorous Retention Index (PRI) is the ability of soils to absorb and treat nutrients within the soil (i.e., Soil microbe disinfecting ability). Soils with a PRI less than 1 have a very poor ability to treat effluent waters, whilst soils with a PRI of >5 having a high ability to treat effluent waters. PRI testing was conducted as part of the site soil investigation (BDS, 2021) at TP9, TP12, TP13, TP16, TP18 and TP21. The PRI results are presented in Table 2.

Table 2: Phosphorus Retention Index Results (CSBP, 2021)

Test Pit	Depth (mm)	Soil Type	Phosphorus Retention Index
TP9	500-1000	Sandy clay	43.9
TP12	200-600	Sand	14.3
TP13	590-880	Sandy clay with gravel	451.4
TP16	500-700	Sandy clay	352.4
TP18	600-800	Sandy clay	>1000
TP18	200-500	Sandy clay	169.5
TP21	400-700	Silty sand	8.1

PRI within the subsurface layers across the Subject Site was found to be high to extremely high, as shown in Table 4. The PRI was found to be consistent with soil type with the soils containing a higher clay content having a higher PRI.

3.7 Surface Hydrology

The Subject Site is generally flat and as such the majority of stormwater ponds on site, either at surface or within agricultural drains that have been constructed across the site. Any discharge off the site north of Treendale Road is in a north westerly direction towards a seasonal creek line within agricultural land to the north west of the Subject Site. The seasonal creek ultimately discharges to the Collie River via a Conservation Category wetland further west of the Subject Site. Stormwater runoff from the site in the southern portion of the Subject Site is to the south towards the Collie River and the adjoining wetlands that are situated between the river and the Subject Site. The Collie River ultimately discharges to Leschenault Estuary to the west. The surface hydrology of the Subject Site is shown in Figure 6.

There are no major water bodies within the Subject Site. There are several manmade drains and farm dams within the site and one naturally formed seasonal creak line with a dammed upstream section in the southwest of the Subject Site. There are also some areas across the site that are subjected to seasonal inundation given the flat nature of the site and its close proximity to the Darling Range to the east, consequently receiving surface water runoff from range.

The Subject Site is located within the Coastal Plain hydrological zone (HZ15_CP) (DPIRD, 2018) and described as; '*Coastal & fixed sand dunes & calcarenite. Non-calcareous sands, podsolised soils with low-lying wet areas. Further inland, alluvial deposits, colluvial deposits adjacent to the Darling Scarp. Clayey to sandy alluvial soils with wet areas.'.*

The Subject Site is also located within one hydrographic catchment being the Leschenault Estuary-Lower Collie Catchment and one hydrographic sub-catchment being the Lower Collie Tribs (DWER, 2018).

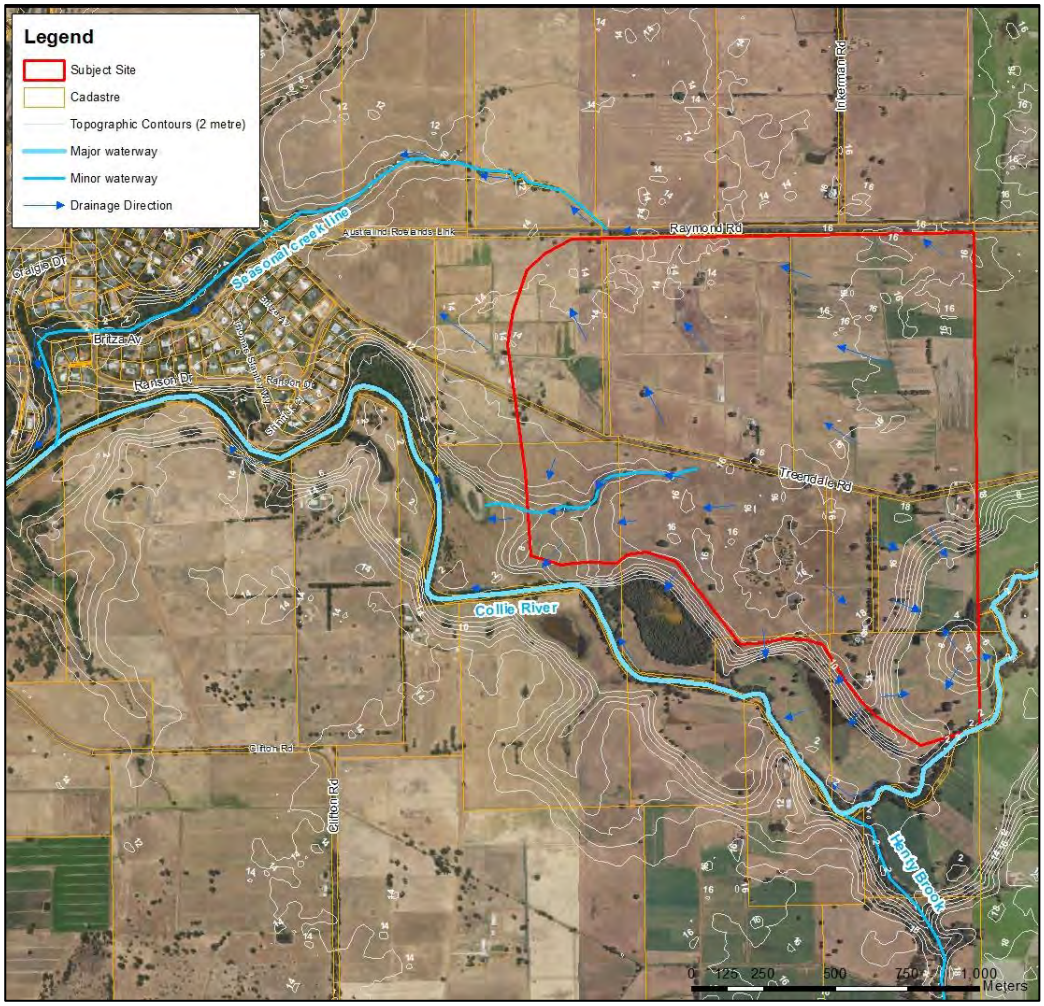


Figure 6: Surface water Hydrology

3.7.1 Hydrological site assessment

A site investigation of the hydrological features was conducted on the 20th and 21st of September 2021 to confirm the surface hydrology of the site and to assist with the design of the post-development drainage. Rainfall in the Roelands area (BoM Station No. 9710) prior to the site investigation was slightly higher than for the same time in an average year. Photographs 1 to 5 show the hydrological features of the site during the site investigation.

Photo 1: A general view to the south of the Collie River. Surface water levels contained within river banks.

Photo 2: View to the east of one of several farm dams on the property. Most farm dams will be commissioned as part of development works.

Photo 3: View to the southeast of wetland within the southeast of the Subject Site. This wetland will have a development setback buffer of 100m.

Photo 4: View to the south of cut drain in the southeast of the site. Cut drains in the Subject Site south of Treendale Road appear to be constructed for drainage of the site where as the drains in the north were constructed for historical flood irrigation use.

Photo 5: View to the north of constructed drain within the northeast of the site.

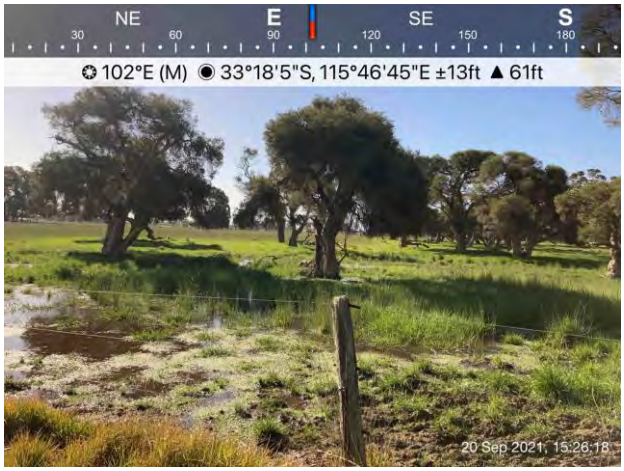


Photo 6: View to the east of seasonally inundated area in the central south. This area is dominated by paperbark trees.

In-situ water quality testing was conducted at various waterway locations on site during the investigation. Water quality results are presented in Table 3.

Table 3: Water quality of Subject Site water bodies

Creek	Temperature (°C)	pH	Electrical Conductivity (dS/cm)	Dissolved Oxygen (mg/L)	Total Dissolved Solids (g/L)
Collie River (east)	14.17	6.91	1.33	9.41	0.852
Collie River (central)	17.98	5.93	1.33	5.80	0.892
Collie River (west)	14.54	6.36	1.28	9.32	0.847
Wetland (southeast)	21.74	6.93	1.63	2.25	1.09
Seasonal creek (west)	20.15	5.81	3.01	6.84	2.02

Water quality testing results found that the surface water within the Collie River was found to be slightly saline with a neutral pH when compared to guideline trigger values presented in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000). The elevated salinity in the Collie River is a likely result of this section of the river being tidal affected. The dissolved oxygen was also consistent with fresh water in the east and the west of the Collie River. The wetland in the southeast was slightly saline with a neutral pH and a low dissolved oxygen consistent with stagnant water bodies. The seasonal creek in the southwest was found to be brackish, with a slight acidic pH and a moderate dissolved oxygen.

The surface water quality discharging to the Collie River, wetlands and waterways shall be maintained or improved in the post-development scenario.

3.8 Hydrogeology and Groundwater

Australian Geoscience Mapping and Department of Water and Environmental Regulation 250K Hydrogeological mapping (DWER, 2001a) places the Subject Site within one hydrogeological zone being Qpgs with the aquifer described as; '*Surficial aquifer - karstic or unconsolidated, extensive or local major to minor groundwater resources'* and the geology described as; '*Guilford Formation - alluvial sand. clay and gravel with minor estuarine and shallow marine lenses Sand member'.*

The Subject Site is not situated within a Priority Drinking Water Catchment Area (DWER, 2001). Desktop analysis of the site indicates that the nearest designated Public Drinking Water Source Area (PDWSA) is the

"Bunbury Water Reserve" as defined by the *Country Areas Water Supply Act 1947* located approximately 12kms southwest of the Subject Site.

The Department of Water and Environmental Regulation Water Information Reporting Tool and Water Register (DWER, 2021) shows 5 domestic groundwater bores/wells detected within a 500m radius of the Subject Site. Of the 5 bores 1 is located within the Subject Site in the central north and the nearest domestic bore to the Subject Site is located approximately 35m to the east of the Subject Site boundary in the southeast.

3.8.1 Groundwater

Groundwater was not encountered in any of the test pits (to a depth of 2-4 metres) during the assessment conducted by Cardno BSD in January 2006 on the area of Subject Site to the south of Treendale Road. While the soils at some locations were observed to be moist the water table was not encountered. Groundwater was encountered at one location (TP8 at a depth of 2.5m BGL) during the geotechnical investigation by Golder and Associates in January 2017 on Lot 1 Treendale Road. Noting both the Cardno BSD and Golder Associates investigations were not conducted during periods where groundwater is at its peak.

The test pits constructed by BDS on the 20th and 21st September 2021 showed a shallow (<0.5m BGL) perched groundwater table across much of the Subject Site. Figure 7 shows the test pits which encountered groundwater <0.5m BGL. The exact high water-table recorded at each test pit is shown on the soil testing logs included as Appendix C. Some areas of the Subject Site where also found to be seasonally inundated during the site investigation. The approximated areas of water logging and seasonal inundation found at the Subject Site during the site investigation are shown in Figure 7.

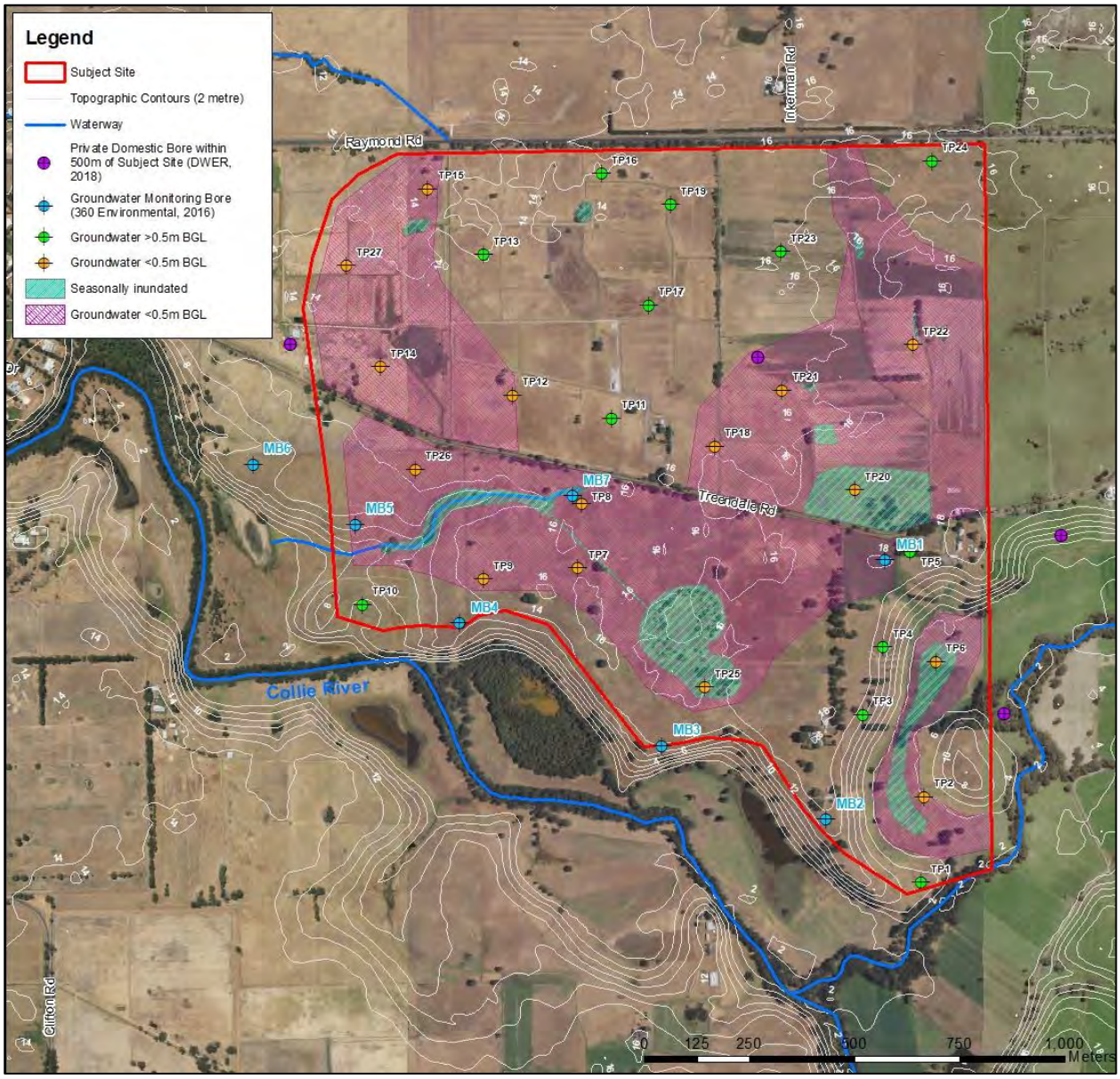


Figure 7: Groundwater, water logging and seasonally inundated areas.

Monthly groundwater monitoring (levels) was conducted from December 2016 to August 2017 by 360 Environmental at 7 groundwater monitoring locations within the area of the Subject Site south of Treendale Road. The monthly depth to groundwater measurement for each monitoring bore is presented in Table 4 and the location of the groundwater monitoring bores is shown in Figure 7.

Table 4: Groundwater monitoring levels Dec 16 to Aug 17 (360 Environmental)

Bore	Bore Depth (m)	Monitoring event								
		Dec-16 (m BGL)	Jan-17 (m BGL)	Feb-17 (m BGL)	Mar-17 (m BGL)	Apr-17 (m BGL)	May-17 (m BGL)	Jun-17 (m BGL)	Jul-17 (m BGL)	Aug-17 (m BGL)
MB1	6	5.11	5.33	5.21	5.06	5.63	5.88	6	5.76	3.54
MB2 shallow	6	dry	dry	dry	dry	dry	dry	dry	dry	dry
MB2 deep	20	5.39	12.16	12.29	12.35	12.45	12.46	12.44	12.3	11.63
MB3	6	dry	dry	dry	dry	dry	dry	dry	dry	3.15
MB4	6	dry	dry	dry	dry	dry	dry	dry	dry	4.95
MB5	6	4.9	4.8	5.05	5.23	5.55	5.76	5.89	5.52	2.13
MB6 shallow	6	dry	dry	dry	dry	dry	dry	dry	dry	3.75
MB6 deep	20	5.31	8.21	8.26	8.26	8.37	8.25	8.1	8	7.35
MB7	6	5.81	1.4	1.56	1	1.6	0.98	1.1	0.74	0.73

The surficial water table was evident at varying depths below ground level across the site. The highest recorded groundwater level was recorded at MB7 during August 2017, being 0.73m BGL, all other groundwater levels recorded across the site were greater than 2m BGL.

3.9 Wetlands

The Subject Site is located within the Leshenault Inlet Management Area which is designated as a Waterways Conservation Act Management Area (WALGA, 2020a)

The southern boundary of the Subject Site is bounded by the Collie River and the Collie River floodplain. The wetlands identified through the Geomorphic Wetlands dataset of the Swan Coastal Plain is presented in Figure 8. Three “Multiple Use” geomorphic wetlands cover the majority of the Subject Site (UFI 15223, 1736 and 1719) which are classified as palusplain, floodplain and sumplands respectively.

One “Conservation” wetland (UFI 1734) is located approximately 230m to the west of the Subject Site, this wetland is classed as a floodplain.

One “Resource Enhancement” wetland (UFI 1870) is located approximately 100m south of the Subject Site and is classed as a sumpland, as shown on Figure 7.

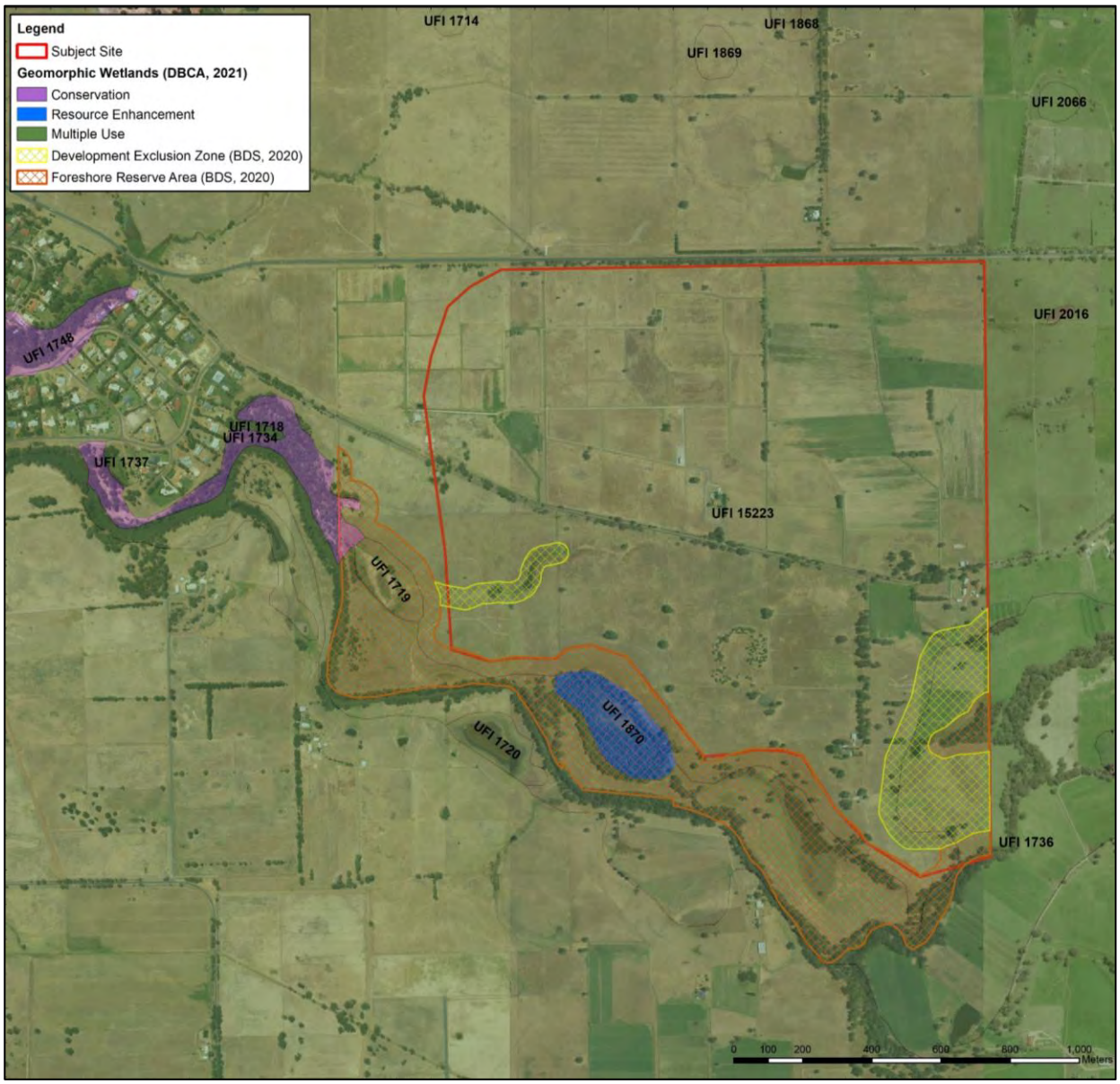


Figure 8: Wetland Mapping

A Wetland Management Plan for the Subject Site and the adjacent wetlands has been prepared by Bio Diverse Solutions (2022). The Wetland Management Plan identifies the potential impacts from the proposed development and management strategies to protect and enhance the wetlands. The wetland management plan identifies a proposed foreshore area and a development exclusion zone to allow adequate setback and protection of the adjacent wetlands. This LWMS shall be in accordance with the Wetland Management Plan (BDS, 2022).

4 Wastewater Management

The Subject Site is situated in an area that does not have access to deep or reticulated sewerage. The health and environmental requirements for wastewater treatment and disposal for developments not serviced by deep sewerage systems are contained in the *Government Sewerage Policy*, (DPLH, 2019). The *Government Sewerage Policy* (DPLH, 2019) states minimum requirements apply for all on-site sewage disposal systems.

A Site Soil Evaluation (SSE) (BDS, 2022) has been prepared for the Subject Site. The SSE details the site soils under late winter conditions and assesses the suitability for on-site effluent disposal across the site in relation to the proposed subdivision.

In summary the SSE identifies the majority of the site as suitable for onsite effluent disposal (BDS, 2021). Given the shallow depth to clay and groundwater across much of the site imported fill with a PRI $\geq$5 and special design requirements and distribution techniques are necessary to ensure the rate of percolation of effluent through the soil is greater than the effluent generation rate.

Irrigation systems (surface or subsurface) in conjunction with a secondary treatment system with nutrient removal have been identified as the most suitable system for future lots. Land application areas and the use of irrigation systems is described in more detail in the SSE (BDS, 2021).

5 Local Water Management Strategy

5.1 Water Sustainability Initiatives

5.1.1 Water Supply

Water supply to households is to be via extension of the scheme water system. The project civil engineer will negotiate the extension of the system with Water Corporation Western Australia.

5.1.2 Water Efficiency Measures

To achieve water efficiency targets, households are to be built consistent with current Building Code of Australia (BCA) water efficiency standards. Water efficiency initiatives are proposed to reduce potable water demand for irrigation of residential lots. These include encouragement of:

- Minimising turf areas;
- Selection of predominantly local native, drought tolerant plants;
- Use of waterwise gardens, restricted lawn areas and water wise lawn varieties;
- Use of rainwater tanks, and
- Community education initiatives on water conservation and reuse.

5.2 Stormwater Management

5.2.1 Design Capacity

The stormwater management system for the development has been designed in accordance with DWER guidelines through the Better Urban Water Management framework and the requirements of the Shire of Harvey. The stormwater drainage system is designed to manage a range of rainfall events up to the 1% AEP. The minor drainage system is designed to provide the structural controls for water quality treatment from the internal road runoff and attenuation of rainfall from lots within the lot boundary. The major drainage system is designed for flood mitigation and protection.

5.2.2 Runoff Coefficients and Sub-catchments

The runoff coefficients are a critical design criterion for the stormwater modelling of the sub-catchments. The pre-development and post-development runoff coefficients assumed for the Subject Site are shown in Table 5.

Table 5: Runoff coefficients

LAND USE	RUN OFF COEFFICIENT		
	First 15mm	20% AEP	1% AEP
Agricultural land	0	0.1	0.2
Road Reserve	0.8	0.8	0.9
Lots (R1)	0	0.4	0.4

It is assumed the first 15mm of rainfall from each storm event from the lots is retained within the lot boundary via the lot stormwater management system as discussed in Section 5.2.4.

The general pre-development hydrological regime is maintained in the post-development scenario, with the northern portion of the Subject Site (north of Treendale Road) discharging to the northwest via the internal road network and the creek line on the northern side of Raymond Road. The southern portion of the site

discharging towards the Collie River to the south via the internal road network and the existing creek line in the southwest.

The post-development drainage sub-catchments are shown in Figure 9. The total area of each sub-catchment and the estimated land use area for each post development sub-catchment is presented in Table 6.

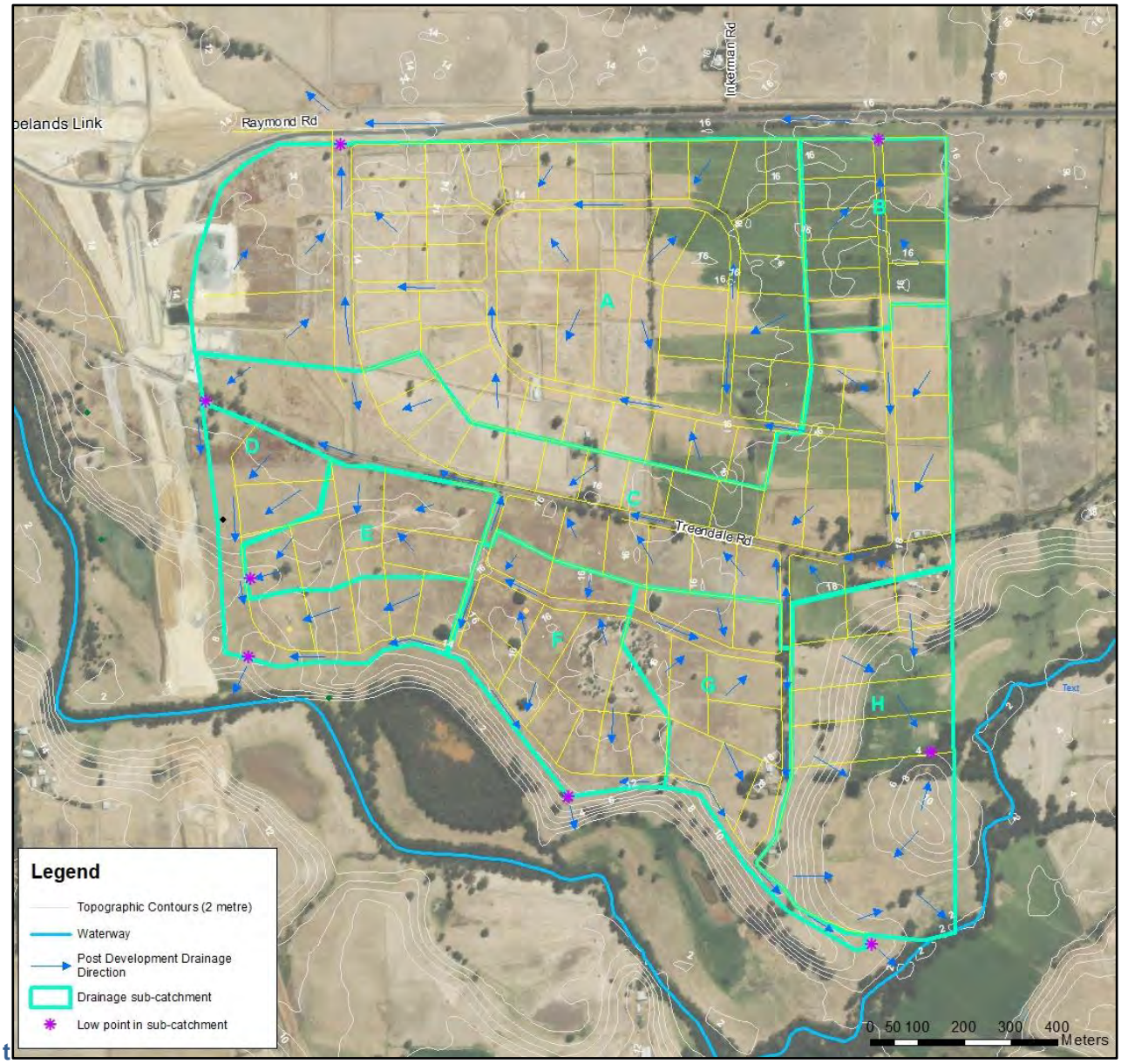


Figure 9: Post-development Drainage Catchments

Table 6: Post-development sub-catchment areas

Land Use (ha)	Catchment							
	A	B	C	D	E	F	G	H
Road Reserve (ha)	6.1	0.9	5.8	4.1	0	2.9	2.9	0
Lots (ha)	68.6	11.0	40.7	9.5	10.1	13.7	12.1	26.3
Total Area (ha)	**74.7**	**11.9**	**46.5**	**13.6**	**10.1**	**16.6**	**15.0**	**26.3**

Sub-catchments E and H contain no proposed internal road area in the post-development scenario. Lots within these sub-catchments will discharge unattenuated from the site consistent with the existing hydrological regime. It is assumed that the majority of the lot area will remain grassed and/or vegetated given the relatively large size (>1ha) of the lots. Landowner's will be responsible for retaining runoff from buildings, hard stand

areas and gardens consistent with the Shire of Harvey's lot attenuation guidelines (see Section 5.2.4), it is therefore expected the change in the runoff coefficient from these sub-catchments without roads will be minimal compared to the pre-development scenario.

Given there is a high point in Treendale Road at the western boundary of the Subject Site no runoff from upstream catchments has been assumed. Runoff from Treendale Road to the west of the Subject Site is directed south to the Collie River.

Runoff from the Subject Site's internal road network and lots discharging to the internal road network will be retained within the Subject Site boundary with outflows from the Subject Site consistent with pre-development flow rates for storm events up to the 1% AEP.

5.2.3 Stormwater Modelling

Multiple storm events have been modelled utilising the Rational Method as described in Australian Rainfall and Runoff (AR & R) (Engineering Australia, 2016). Pre-development outflow rates have been calculated based upon peak flow stream discharge as determined by Section 1.4 of AR & R.

Rainfall intensities for the various storm events and storm durations are calculated and provided by the Bureau of Meteorology (BoM) computerised design Intensity Frequency Duration (IFD) Data System (www.bom.gov.au). Calculations have been undertaken utilising up to date IFD charts.

The Boyd method has been utilised to calculate the stormwater storage volume required for each sub-catchment based on the post-development runoff from the site and the allowable outflows set for the stormwater storages, which are determined by the peak pre-development outflow rate. The Boyd method is considered a conservative estimate of stormwater storage volume calculation.

5.2.4 Drainage System Requirements

Key elements of the proposed drainage system strategy are as follows:

Lot Attenuation

- It is the landowner's responsibility to manage stormwater runoff from buildings, hard stand (impervious) areas and gardens within the property boundary consistent with the Shire of Harvey lot attenuation guidelines. Lot stormwater management systems should be designed as per the following Shire requirements:
  - Class A lots (sandy free draining soil) must attenuate and infiltrate stormwater into the surrounding sand to the volume of 1m³ per 100m² of impervious area. Perforated soakwells, rainwater tanks and/or rain gardens may be used to achieve the required rate of attenuation (SoH, 2022).
  - Class S – Class P lots (clay and/or reactive ground) must provide stormwater storage to the volume of 1m³ per 65m² of impervious area. Sealed soakwells, rainwater tanks and/or rain gardens may be used to achieve the required rate of attenuation. Property owners may be permitted to discharge attenuated stormwater into the Shire's road drainage network where suitable (SoH, 2022).
- Rainwater tanks are recommended on all lots and shall be plumbed into homes using a mixed demand system or a trickle feed system to provide available storage for recurrent storm events.
- Soakwells shall only be utilised where there is adequate separation to groundwater (>300mm) and adequate gradient for graduated pipe overflow pipes. Given the shallow depth to groundwater attenuation basins integrated into the garden landscaping will provide the most effective attenuation mechanisms. When designing lot stormwater management systems overland flow routes directing runoff away from buildings and adjoining properties shall be considered (SoH, 2022). Lot stormwater management systems should be assessed and approved by the Shire of Harvey upon Development Application.

- Cut-off swales to be located on the low side/s of all lots which pose a threat of inundating neighbouring properties. Given the relatively flat nature of the site the location of the cut-off swales shall be determined subsequent to earthwork design to determine the lots and the side/s of lots posing a flooding risk. The lot owner's shall be responsible for maintaining the cut-off swale as per the intended design.

Stormwater Conveyance

- Roads graded to direct overland flow to the lowest point in each sub-catchment.
- Roadside swales designed to convey storm events up to the 1% AEP. Where required, pipe drains to connect sections of swale sized to convey the 1% AEP storm event. Pipe drains include lot crossovers which shall be constructed prior to subdivision to ensure the integrity of the drainage system is maintained.
- Roadside swales shall have a minimum side slope of 1:4 between the road and swale and 1:5 between the lot boundary and swale for ease of maintenance. The swales shall be designed with adequate grade for peak runoff conveyance, the minimum grade criterion for the swales is 1:200 (0.005). The estimated capacity and top water level of each section of swale shall be calculated using the Manning's formula or appropriate modelling software subsequent to earthwork design once the incoming sub-catchment to each swale section is confirmed. Generally, to convey runoff from the whole of the largest sub-catchment (Sub-catchment A) a v-drain with the capacity to convey 1.88m^2 is required, using Manning's formula and the minimum grade criteria this results in a maximum flow depth of 0.58m and a top water width of 5.2m. The downstream section of Treendale Road Reserve has a proposed width of 40m, which is adequate to accommodate the required swale size for Sub-catchment A.

Bio-retention and Stormwater Storage

- Bio-retention/stormwater storages shall be designed to retain up to the 1% AEP. The maximum side slopes for the bio-retention storages is 1:6. The base of the bio-retention storage shall be graded (minimum grade of 1:50) to direct stormwater to the bio-retention treatment area within the low point of the storage, which is sized to retain and treat up to the 20% AEP storm event. A cross section of the storage is shown in Figure 11 and sizing of the bioretention/stormwater storages for each sub-catchment is shown in Table 7.
- The base of the bio-retention storage shall be underlain with 0.4m depth of amended soil, 0.15m depth of a transition layer (coarse sand) and 0.15m depth of a drainage layer with 100mm (maximum) perforated collection pipes (subsoils), as shown in Figure 11. Bio-retention storages shall be planted, the specifications for the amended soil and the planting are provided in Section 5.4.
- Outflow from the bio-retention storages for minor storm events (up to the 20% AEP) shall be set at the top water level of the first 15mm runoff event, this is set at a maximum depth of 0.3m to allow for adequate water quality treatment across a larger surface area. Outflow from the storages will be via an overflow pit sized to match the peak pre-development outflow for the 20% AEP storm event for each sub-catchment (Table 7).
- Outflow from the stormwater storages for major storm events (from the 20% AEP up to the 1%AEP) shall be set at the top water level of the 20%AEP storm event. Outflow from the storages for the major storm event will be via an overflow pit sized to match the peak pre-development outflow for the 1% AEP storm event for each sub-catchment (Table 7).
- Outflow from the bio-retention/stormwater storages shall be directed towards the low lying areas fronting the Collie River in the south of the site and the outlet crossing underneath Raymond Road in the northwest of the site. Given the steep slopes from the Subject Site to the low lying areas fronting the Collie River outflow from the bio-retention storages in the south (Sub-catchment D, F and G) shall be via a graduated outfall system designed to reduce velocity. The velocity of outflow shall not exceed 0.5m/s and measures shall be taken to ensure scouring and movement of sediment is minimal, this shall include rock pitching and potentially planting and stabilisation matting. Graduated outfall design shall be specified at detail design stages in conjunction with earthwork and civil design once the final

location of the storages has been determined. Direct discharge to the Resource Enhancement Wetland directly south of the Subject Site shall be avoided.

- Sub-catchment B stormwater storage and water quality treatment shall be provided in the roadside swale either within the sub-catchment or within the Subject Site adjacent to Raymond Road. Design of the bio-retention/stormwater swale within Sub-catchment B shall be consistent with the bio-retention/stormwater storage specifications. Discharge from Sub-catchment B bio-retention/stormwater swale will be directed to Raymond Road, with outflows consistent with pre-development flow rates. Raymond Road ultimately discharges to the creek to the northwest of the Subject Site consistent with the northern portion of the Subject Site.
- Sub-catchment C bio-retention/stormwater storage is not located adjacent to an external waterway. A swale shall be constructed within the Subject Site adjacent to the BORR directing treated outflow towards the Collie River. The swale shall have grades consistent with the roadside swales and be planted consistent with the bio-retention storages. It should also be stabilised and graduated to minimise outflow velocity to 0.5m/s reducing the potential for sedimentation and erosion.
- Runoff from Catchment E will be directed to the existing creek line via sheet flow consistent with the pre-development scenario with outflow from the creek via a culvert crossing underneath the proposed internal road in the southwest of the Subject Site, directing outflow towards the constructed swale running parallel with the BORR as mentioned above and ultimately the Collie River (Figure 10).
- All building pad finished levels shall have a minimum 0.5 m separation above the estimated 1% AEP top water level in the storages and swales and all roads shall have a minimum separation of 0.3m above the estimated 1% AEP top water level in the storages and swales consistent with the Local Government Guidelines for Subdivisional Development (IPWEA, 2017).
- A stabilised low point in the bank of the storage shall be provided at the 1% AEP top water level, located downstream in the storage so that stormwater is directed off site when/if the storage capacity of the storage is exceeded.
- All bio-retention storages shall be contained within easements and have adequate access for maintenance.

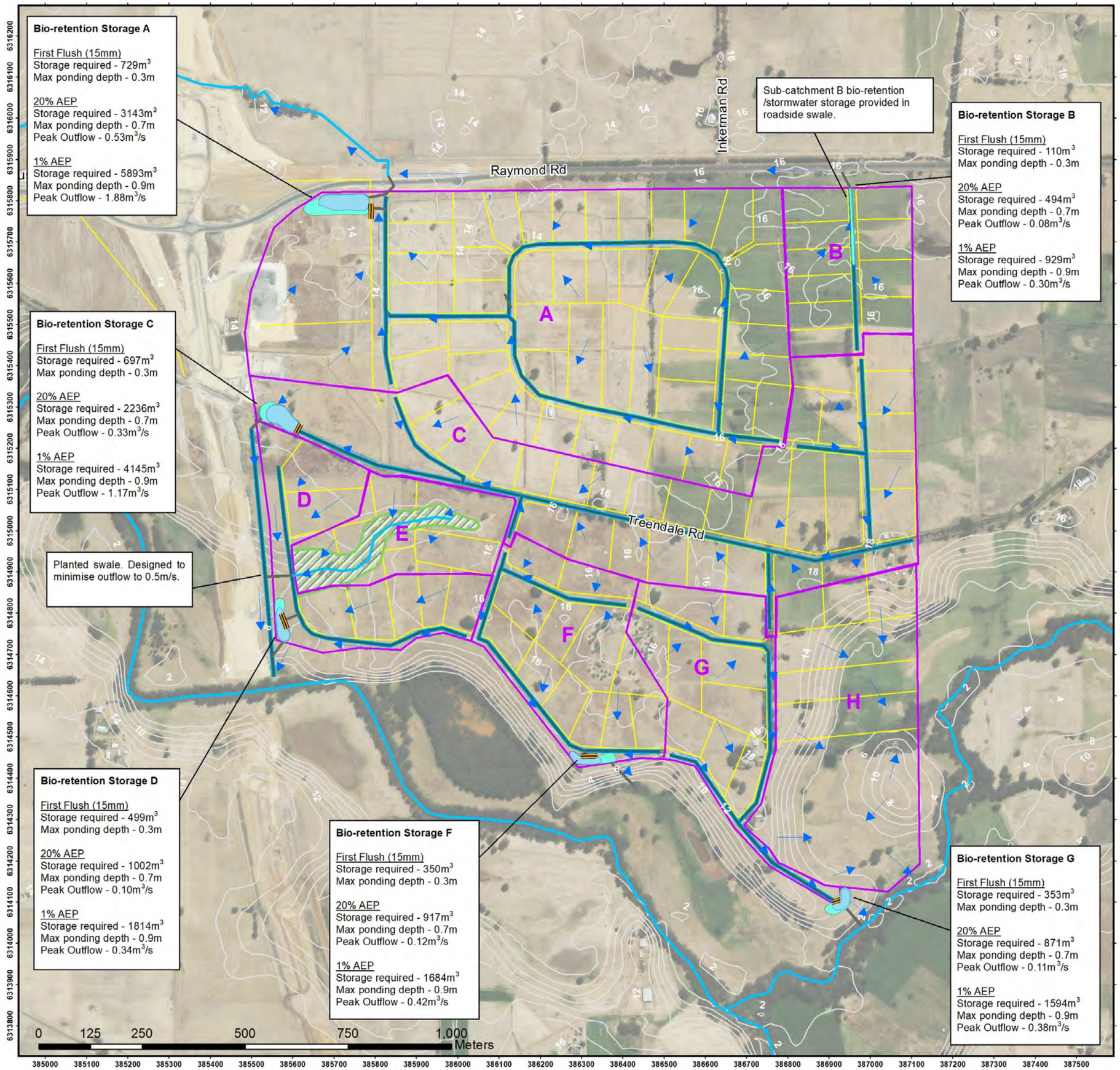
The First 15mm, 20% AEP and stormwater storage requirements are presented in Table 7. The stormwater management strategy for the Subject Site is shown in Figure 10.

Table 7: Drainage system requirements

	Sub-catchment					
	A	**B**	**C**	**D**	**F**	**G**
First 15mm						
Runoff Volume (m^3)	729	110	697	499	350	353
Storage Volume required (m^3)	729	110	697	499	350	353
Ponding Depth (m)	0.3	0.3	0.3	0.3	0.3	0.3
20% AEP						
Critical Storm Duration (hours)	1	1	1	1	1	1
Storm Duration Runoff Volume (m^3)	4088	644	2875	1239	1164	1101
Storage Volume required (m^3)	3143	494	2236	1002	917	871
Max Ponding Depth (m)	0.7	0.7	0.7	0.7	0.7	0.7
Peak Outflow from Storage (m^3/s)	0.53	0.08	0.33	0.10	0.12	0.11
1% AEP						
Critical Storm Duration (hours)	1	1	1	1	1	1
Storm Duration Runoff Volume (m^3)	10791	1707	7304	2843	2855	2664
Storage Volume required (m^3)	5893	929	4145	1814	1684	1594
Max Ponding Depth (m)	0.9	0.9	0.9	0.9	0.9	0.9
Peak Outflow from Storage (m^3/s)	1.88	0.30	1.17	0.34	0.42	0.38

5.2.5 Seasonally inundated areas

There are three areas identified as being subjected to seasonally inundation (Figure 7) lots within these areas have been made larger to ensure they have an area outside of the seasonally inundated area suitable for building. The building pad level will require imported fill to achieve both the groundwater separation requirement (Section 5.3) and the 0.5m separation from building pad level to the 1%AEP flood levels. Cut off swales may be required within the seasonally inundated lots to direct runoff towards roadside swales and ultimately the stormwater storages.



This BAL Plan was prepared by:
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Jurisdiction: Level 2 - WA

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Legend

- Proposed lot layout
- Topographic Contours (2 metre)
- Waterway
- Drainage sub-catchment
- Post-development drainage direction
- Low point in the road/low kerb
- Constructed swale
- Proposed revegation area
- Stormwater Storage (1% AEP
- Bio-retention Storage (20% AEP

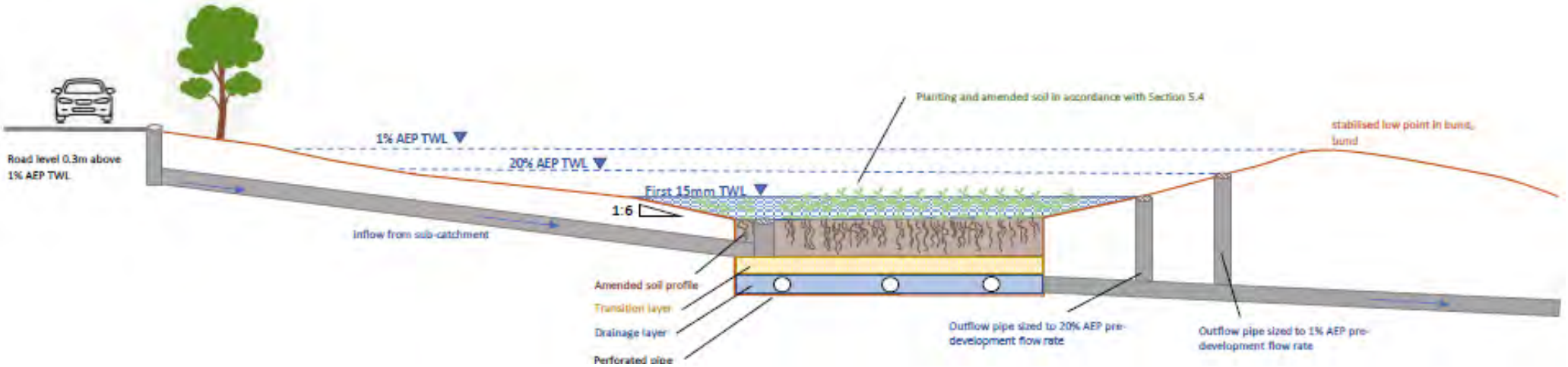
Scale
1:9,000 @ A3
GDA MGA 94 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

CLIENT
Tecon Australia
Treendale Structure Plan, Treendale Road
Roelands, WA 6226

Figure 10: Stormwater Management Plan

BAL Assessor	*QA Check*	*Drawn by*
CC	**KK**	**CC**
STATUS	*FILE*	*DATE*
FINAL	**MSC0285-003**	**02/08/2022**



Note: Not to scale

Figure 11: Conceptual cross-sections of bio-retention storage

5.3 Groundwater Management

The groundwater management objectives for the Subject Site are to:

- Manage groundwater levels to protect infrastructure and assets;
- Maintain groundwater regimes for the protection of groundwater dependent ecosystems;
- Protect the value of groundwater resources; and
- Adopt nutrient load reduction design objectives for discharges to groundwater.

The following strategies will be implemented for the proposed development of the Subject Site to ensure the above objectives are met:

- To protect infrastructure from high seasonal groundwater levels imported fill will be required to achieve the minimum separation of 2 metres between finished building pad level and the maximum seasonal groundwater table. A perched groundwater was encountered <0.5metres below ground level across much of the site (Figure 7) and therefore fill will be required for building envelopes across the entire site to achieve the groundwater separation requirement.
- Subsoil drains shall be installed where the road finished level is less than 2.0m above the maximum seasonal groundwater level. Subsoil drains shall have free draining outlets to bio-retention/stormwater storages for treatment prior to discharge.
- Bio-retention storages to have subsoils beneath the amended soil layer to prevent long standing water. Subsoil drains shall have a free draining outlet directed to the flood plain areas in the south or the creek to the northwest.
- Maximum seasonal groundwater levels (Groundwater Design Levels) shall be confirmed prior to subdivision. Groundwater monitoring to determine Groundwater Design Levels is discussed in Section 6.4.1.

5.4 Water Quality Management

The effective implementation of the structural and non-structural controls as part of the development will enhance water quality from this site as a result of the land use change from agricultural to rural residential.

The Subject Site uses a treatment train of structural and non-structural controls to treat up to the first 15mm of rainfall from storm events.

Structural controls include the use of:

- Lot attenuation through the use of plumbed in rainwater tanks, soakwells and/or rain gardens to capture runoff from rooves and hardstand areas reducing runoff from the site. Infiltration of rainwater at source allows for treatment of water as it moves through the soil profile.
- Bio-retention storages which will receive runoff from the development's internal road network. Bio-retention storages are designed to treat the first flush event (first 15mm) and retain up the 1% AEP storm event. Bio-retention storages will allow for infiltration at source, they will be underlain with amended soil and subsoils and planted to allow for plant root uptake of nutrients and heavy metals. The minimum specifications for all bio-retention storages are presented in Table 8.
- Revegetation of creek line in the southwest. Revegetation of the inner creek line shall be consistent with minimum requirements for the bio-retention storages and swales (Table 8) with larger native shrubs suitable for the outer creek line. Figure 10 shows the area proposed to be revegetated. Revegetation of the creek line shall be established prior to subdivision and shall be maintained by the lot owners.

Table 8: Minimum requirements for bio-retention storages and swales

Item	Specification
Amended soil media	• Well graded sand. • Clay and silt content <3%. • Organic content between 3 and 5%. • Hydraulic Conductivity (sat) >150mm/hour. • Light compaction only. • Infiltration testing of material prior to installation and again once construction is complete. On-going testing as per the monitoring program.
Plant selection	• In accordance with Vegetation Guidelines for Stormwater Biofilters in the South-West of WA (Monash University, 2014). • Tolerant of periodic inundation and extended dry periods. • Spreading root system. • Preferential selection of endemic and local native species. • Planting to provide 70-80% coverage at plant maturity.
Planting density and distribution	• Planting density appropriate for species selection. • Even spatial distribution of plant species.

The bio-retention systems should be sized to function correctly with a hydraulic conductivity (K) (saturated) of at least 3 m/day. Research conducted by the Facility for Advancing Water Biofiltration (FAWB, 2008) indicates that the desired K_{sat} is in the range of 2.5 to 7 m/day, to fulfil the drainage requirements as well as retain sufficient moisture to support the vegetation. The FAWB (2008) research also specifies that for vegetated systems some clogging will occur in the first few years until the vegetation is established. Once the plants are established, the roots and associated biological activity maintain the conductivity of the soil media over time.

Bio-retention systems and the creek line in the southwest are to be planted in a low fuel manner so as to not increase the bushfire risk of the area.

Non-structural source controls to reduce nutrient export from the Subject Site will focus on reducing the need for nutrient inputs into the landscape. The following strategies are proposed for new lot owners, with the developer responsible for the transfer of information at point of sale;

- Promotion of the use of local native plants for landscaping to new lot owners. The use of local native plants will reduce the need for fertilisers across the site; and
- Undertake education campaigns regarding source control practices to minimise pollution runoff into stormwater drainage system.

6 Implementation

6.1 Urban Water Management (Subdivision)

As a condition of subdivision and prior to any subdivision activities an Urban Water Management Plan/s (UWMP) is required.

Further works that are identified for inclusion in the UWMP/s (next planning stage) include:

- Confirm staging of the development and implications for stormwater and groundwater management.
- Testing of in-situ soil media to determine if the existing soil profile meets the minimum specifications for bio-retention systems, outlined in Table 8. A suitable amended soil media shall be agreed upon prior to detailed design stage.
- Refine the final configuration and exact location of the bio-retention/stormwater storage areas, which are dependent on final earthworks, drainage and road design levels for the development.
- Confirm invert levels of bio-retention/stormwater storage and outlet pipes. Also confirm sizing of outlet pipes/orifice plates.
- Detailed design of graduated outfalls from stormwater storages in the south.
- Confirm sizing of roadside swales to ensure they have adequate capacity for stormwater conveyance of up to the 1% AEP to prevent any breakout areas.
- Confirmation of any subsoils, including location and levels.
- Confirm peak seasonal groundwater levels (Groundwater Design Levels) across the site and groundwater quality baseline data.

6.2 Construction Management

Any temporary stormwater storage required during construction shall be built where the final storage area will be located. The temporary storage will be sized to contain the ultimate capacity of stormwater runoff from the connected area. Measures shall be taken to prevent the transportation of sediment during the construction phase including infiltrating at source where possible and sand bagging/rock placement at the inlet of any pipe systems discharging outside the Subject Site. Remedial measures shall be undertaken by the developer if any disturbances to the surrounding areas are caused during construction.

It is recommended staging of the development be consistent with the development's sub-catchments to better manage stormwater runoff and minimise the area subjected to erosion, sediment movement and flooding during construction.

Civil engineering design shall be in accordance with this LWMS to ensure the effectiveness of the proposed drainage design and water management strategies.

6.3 Maintenance of Drainage Systems

The bio-retention storages and drainage system will require regular maintenance to ensure its efficient operation. It is considered the following operating and maintenance practices will be required and undertaken by the client periodically until successful practical completion of the development and handover to the Shire of Harvey. Following handover, it is the Shire of Harvey's responsibility to maintain drainage structures accordingly:

- Removal of debris to prevent blockages;
- Maintenance of vegetation in bio-retention storages; and
- Cleaning of sediment build up and litter layer on the bottom of storages.

6.4 Monitoring Program

The monitoring program has been designed to allow a quantitative assessment of hydrological impacts of the proposed development.

6.4.1 Hydraulic Performance Monitoring

The hydraulic performance monitoring will aim to measure the movement of storm water through the stormwater storage structures to determine if stormwater conveyance is consistent with the intended design.

Where amended soil profiles have been installed in the bio-retention storages, infiltration testing shall be completed to test the hydraulic conductivity of the media. Testing should be repeated every 12 months to ensure clogging of the storages does not occur.

Water levels in the bio-retention storages shall be observed during significant storm events to ensure they are consistent with design and not overflowing.

6.4.1 Groundwater Monitoring

It is recommended that groundwater levels and quality monitoring from the existing monitoring bores in the south of the site continue for one further year prior to development. It is also recommended that a series of groundwater monitoring bores (minimum of 12 bores) be established, with a minimum of 6 bores proposed in the north of the site (north of Treendale Road) and a minimum of 6 bores proposed in the south of the site. Groundwater monitoring bores shall include both deep and shallow bores to capture both the local surficial groundwater table and the perched water table. Bores shall be monitored for one year prior to development. Groundwater monitoring (levels and quality) shall be measured quarterly and include one late winter period to enable the establishment of baseline data.

Two years of post-development groundwater level and quality monitoring (quarterly) shall be conducted from the bores with results compared to pre-development results. If groundwater levels are found to exceed pre-development groundwater levels by more than 500mm with no significant change in rainfall a review of the development design and operations will be required and alterations/modifications to the development shall be conducted to reduce groundwater levels accordingly. If groundwater quality results show significant change/exceedances of water quality trigger values a review of the development design and operations will be required and alterations/modifications to the development will be conducted to improve the groundwater quality.

Water quality parameters to be tested include; pH, EC, TDS, Total Phosphorus (TP), Orthosphosphate (PO4), Total Nitrogen (TN), Total Kjeldahl Nitrogen (TKN), Ammonium (NO4), Nitrate and Nitrite (NOx), Total Suspended Solids (TSS), Heavy Metals and Total Petroleum Hydrocarbons (TPH). All sampling is to be conducted according to Australian Standards and all water quality sample testing will be conducted by a NATA approved laboratory.

The pre-development groundwater monitoring results shall be presented in the relevant UWMP/s outling groundwater design levels and baseline groundwater quality data. The post-development results shall be presented as an annual monitoring report. The preparation of an annual monitoring reports is to be co-ordinated by the developer and submitted to the DWER/SoH for review. The report will compare the monitoring results with the design criteria and performance objectives to determine what, if any, further actions may be necessary.

7 References

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Appendix A

Environmental Assessment and Land Capability Assessment (Cardno BSD, 2006)

Cardno BSD

LOTS 121, 246, 314 & 3315 TREENDALE ROAD, ROELANDS

ENVIRONMENTAL ASSESSMENT AND LAND CAPABILITY STUDY

COLLIE RIVER INVESTMENTS PTY LTD

MARCH 2006 JOB NO. V6003

Lots 121, 246, 314 & 3315 Treendale Road, Roelands Environmental Assessment and Land Capability Study

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Cardno BSD Pty Ltd

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1. INTRODUCTION

1.1 BACKGROUND

Lots 121, 246, 314 & 3315 Treendale Road, Roelands (the 'study area') is proposed to be rezoned from "Rural" to "Special Residential" under the Shire of Harvey District Planning Scheme (DPS) No. 1. Given that such changes in land use can have implications for the existing environment, it is generally necessary to undertake an environmental assessment to determine the degree to which significant impacts could arise.

The proposed rezoning of the study area is consistent with existing development of adjacent areas, which have seen the development of similarly sized lots for "Special Residential" purposes.

1.2 SITE DESCRIPTION

The study area is located within the locality of Roelands and Shire of Harvey, approximately 150km south of the Perth Metropolitan area. The location of the study area is shown in **Figure 1**. The study area is situated immediately adjacent to the Collie River, to the east of Australind and is comprised of approximately 124ha of predominantly cleared land. The Collie River borders the study area to the south, east and west, while the northern border of the study area is defined by Treendale Road.

1.3 PURPOSE OF THIS REPORT

Cardno BSD were engaged to investigate the existing environmental conditions and conduct a land capability assessment, both with the aim of determining the suitability of the study area for the proposed use ('Special Residential') and also the capability of the site to support onsite effluent disposal (specifically through the use of Ecomax™ treatment units). This report is intended to document the findings of the above investigations and support both the DPS rezoning and future subdivision of the site.

2. EXISTING ENVIRONMENT

2.1 SOILS AND TOPOGRAPHY

2.1.1 Soils and Landforms

The Swan Coastal Plain is generally flat, approximately 20 – 30kms wide and consists of a series of geomorphic entities running parallel to the coastline. The northern part of the Plain is formed from either fluviatile or aeolian depositional material. The coastal plain itself is low lying, often swampy with Sandhill's and therefore the soils predominately consist of recent sands or swampy deposits (Beard, 1990). The Swan Coastal Plain consists of the Pinjarra Plain and three dune systems (Quindalup, Spearwood and Bassendean) of differing ages of deposition whose soils are at different stages of leaching and formation.

The Landform and Soil units of the surrounding area have previously been mapped by Churchward and McArthur (1978). These maps indicate that the landform and soil types underlying the Fluviatile Deposits of the Swan Coastal Plain Landform and Soil unit, on which the study area is located, are comprised of the "Guildford" and "Swan" soil types. The Guildford soil type is typically represented by flat plains with medium textured deposits comprised of yellow duplex soils. The Guildford soil type corresponds with the gently sloped and cleared pasture areas within the site. The Swan soil type is represented by alluvial terraces with red earths and duplex soils. This soil type corresponds with the alluvial floodplain of the Collie River.

Further guidance as to the soil characteristics and topography of the study area is provided by the *Land Resource Mapping for Harvey to Capel on the Swan Coastal Plain Western Australia* (Barnesby & Proulx-Nixon, 1994). This mapping indicates that the entire site (with the exception of one wetland) is regarded as a part of the Pinjarra Soil-Landscape System. The wetland area is regarded as being a 'Miscellaneous Swamp' and is further described in **Section 2.5.3**.

Within the study area the larger northern portion consists of cleared pasture comprised of flat to very gently undulating plain with acidic mottled yellow duplex soils, comprising moderately deep/shallow pale sand to sandy loam over clay, being imperfectly drained (mapping unit P1b and P1a). This landform includes the steep slopes and valleys that serve as a transition between the undulating cleared pasture and the floodplain of the Collie River. The floodplain (southern) portion of the study area is gently undulating to flat terraces adjacent to the Collie River, but is well below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding (mapping unit P10). In addition to the above landforms that underlie the majority of the site, a small circular area is located centrally within Lot 3315 (approximately 2ha) and is a seasonally inundated swamp/depression with very poorly drained variable acidic mottled yellow and gley duplex soils (mapping unit P7).

These soil-landscape mapping units are shown in **Figure 2**, and were confirmed by the site investigations, detailed in **Section 2.1.4**.

2.1.2 Topography

The larger northern portion of the study area varies in height from 18m AHD in proximity to Treendale Road to 4m AHD at the point where it meets the Collie River Floodplain. This results in slopes ranging from 0% to 17%, with a generally southerly aspect. The floodplain of the Collie River varies in width from 20m to 450m and varies in elevation from 0m AHD to 4m AHD. Topographical contours of the study area and major landforms are shown in **Figure 3**.

2.1.3 Site Specific Investigations

In order to provide a measure of on-ground verification of site characteristics that can in turn be used to conduct a land capability assessment (see **Section 4.1**), a number of site-specific parameters were further investigated. These are further discussed in the following sections.

2.1.3.1 Test-pitting

In order to clarify the underlying soil composition on the study area, 14 test-pits were excavated by backhoe to a maximum depth of 3.5m. The location of the test-pits is shown on **Figure 2**. Soil logs of the test-pits can are contained in **Appendix A**. A visual record of the test pit soil profiles is shown in **Plates 1-14**. The composition and profile of the soils was logged and soil samples were taken for analysis. Visual inspection of the soil profile confirmed the predicted soil types, though there was some variability of these across the site.

The soil types underlying the northern portion of the site (test-pits RL1 to RL3, RL5, RL6 and RL9, RL 11 and RL12) were duplex soils, with varying depths (0.2m to 0.7m) of pale quartz sand overlying dense highly plastic clays. The clays were observed to be mottled at depths of 0.7-2.7m throughout this landform, and while these were not observed to be saturated at the time of test-pitting (January 2006), it can be inferred that this mottling is indicative of a perched winter watertable or very low vertical hydraulic conductivity of these portions of the soil profile with the underlying superficial aquifer. Two exceptions to the soil types predicted to underlie the northern portion of the site were found at test pits RL13 and RL14. In these areas the soil profile consisted of red earths to 1.3m overlying hard packed yellow/orange and white/grey clay. Location RL14 was particularly hard-packed and cemented.

Soil types underlying the P7 area were test-pitted (RL4). This area was found to be dense dry clay over cementitious quartz and laterite. The test pit at this location was difficult to excavate and can be considered to be completely impermeable. This was confirmed by the current landowner, who indicated that stormwater runoff does not drain from the area without the assistance of an artificial drainage channel.

Soil types underlying the southern floodplain portion of the site (test pit locations RL7, RL8 and RL10) were found to be red/brown loamy earth of between 1.2m and 2.7m depth, overlying mottled grey/brown, orange/yellow or red/orange clays. These soils are consistent with those that could be expected to be found within alluvial floodplain areas.

Overall the surface soils can be considered to allow moderate infiltration within the surface horizon layer. However, any infiltration of rainfall would be limited by the underlying clay layer, and therefore overall infiltration is likely to be low once the soils are saturated.

2.1.3.2 Soil Analysis

Soil samples were collected from each of the test pits at a depth of 0.2m, in order to capture the characteristics of the different soil types observed. The samples were analysed by a National Association Testing Authority (NATA) accredited laboratory for Bicarbonate Extractable Phosphorous (Bic P), Total Phosphorous (TP) and Phosphorous Retention Index (PRI). This analysis was intended to provide a measure of exchangeable phosphorous, background phosphorous and an indication of the short-term P-retention capacity of the soil (respectively). Samples were not proposed to be analysed for Nitrogen as this is converted rapidly to the nitrate form, which is not adsorbed by soils and is rapidly leached. The results of the soil sample analysis are shown in **Table 2.1.3.2**.

Table 2.1.3.2 Soil Analysis Results

Sample ID	Bic P (mg/Kg)	TP (mg/Kg)	PRI
RL1	41	110	1.8
RL2	16	67	59.7
RL3	8	66	6.5
RL4	21	101	76.2
RL5	-	-	-
RL6	-	-	-
RL7	11	145	115.1
RL8	77	458	159.6
RL9	71	442	36
RL10	14	315	1,427.7
RL11	27	132	55.8
RL12	-	-	-
RL13	103	435	71.2
RL14	174	562	80.7

The laboratory analysis results are also contained in **Appendix B**.

The sample analysis indicates that the nutrient retention capacity of the alluvial floodplain surface soils is very high, while nutrient retention capacity of the surface soils underlying the northern portion of the study area was comparatively low. Nutrient levels within the soils were comparatively high at locations RL8, RL9, RL10, RL13 and RL14, though this is not surprising given that the land is currently used for agriculture. Continued phosphorus application to soils (even those with high PRI) can lead to leaching of phosphorous from soils. However, given the overall high PRI and generally moderate TP of the northern portion of the study area, the soils underlying the northern portion of the study area can be considered to be suited to domestic effluent disposal in terms of nutrient retention ability.

2.1.4 Acid Sulfate Soils

Acid Sulfate Soils (ASS) are naturally occurring soils that contain iron sulphide (iron pyrite) minerals. If disturbed by dewatering, drainage or soil excavation, the pyrites can oxidise thereby release acidity, potentially causing environmental impacts. An overview of the Acid Sulphate Soils (ASS) risk potential on the Swan Coastal Plain is provided in the *Western Australian Planning Commission Planning Bulletin Number 64* (WAPC, 2003). According to the Bulletin, the soils underlying the study area are rated as having a moderate to low risk of actual ASS or potential ASS occurring generally at depths greater than 3m.

2.2 FLORA AND VEGETATION

2.2.1 Background Information

The survey area lies on the Swan Coastal Plain Subregion of the Drummond Botanical Subdistrict within the southwest Botanical Province as described by Beard (1990). Flora composition of the Swan Coastal Plain Subregion has been described by Beard (1990) as predominantly consisting of *Banksia* Low Woodlands on leached sands with *Melaleuca* swamps where ill drained and Woodlands of *Eucalyptus* spp. on less leached soils.

The study area is located on the Fluviatile Deposits of the Swan Coastal Plain landform and Soil Unit. The Fluviatile Deposits underlying the study are comprised of Guildford and Swan Complex vegetation (Heddle *et al*, 1978). The vegetation of the Guildford Complex is typically a mixture of open forest of tall *Eucalyptus wandoo, E. marginata* and *Corymbia calophylla* and woodland of *E. wandoo* (with rare occurrences of *E. lane-poolei*). Minor components include *E. rudis* and *Melaleuca rhaphiophylla.* Heddle *et al.* (1980) describes the vegetation of the Swan Vegetation Complex as predominantly fringing woodlands of *Eucalyptus rudis, Melaleuca rhaphiophylla* with localised occurrences of *Casuarina obesa* and *Melaleuca cuticularis.*

2.2.2 Declared Rare Flora and Priority Listed Flora – Existing Information

Species of flora acquire Declared Rare Flora (DRF) or Priority Flora (PF) conservation status where populations are restricted geographically or threatened by local processes. The Department of Conservation and Land Management (CALM) recognise these threats and subsequently applies regulations towards population protection and species conservation. CALM enforce regulations under the *Wildlife Conservation Act 1950* (WAWC Act) to conserve DRF species and protect significant populations. PF species are potentially rare or threatened and are classified in order of threat.

CALM's Declared Rare and Priority Flora list indicates that a number of species of conservation significance are potentially located in the Bunbury locality, including *Acacia flagelliformis* (P4), *Aponogeton hexatepalus* (P4), *Caladenia speciosa* (P4), *Pultenaea skinneri* (P4), *Rhodanthe pyrethrum* (P3), *Stylidium longitubum* (P3) and *Verticordia attenuata* (P3). However, a search of CALM's *Threatened (Declared Rare) Flora* database indicates that there were no known occurrences of any of the above species within the study area. The results of the CALM database of DRF and Priority Flora search are contained in **Appendix C**.

The Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) promotes the conservation of biodiversity by providing strong protection for plants at a species level. However, none of the species noted above are scheduled under the EPBC Act.

2.2.3 Threatened Ecological Communities

Ecological communities are naturally occurring biological assemblages that occur in a particular type of habitat, are the sum of species within the ecosystem and as a whole provide many of the processes that support specific ecosystems. CALM has been identifying Threatened Ecological Communities

(TECs) for a number of years with the aim of developing and implementing recovery plans for these. While they are not afforded direct statutory protection at a State level (unlike DRF under the WAWC Act) their significance is acknowledged through other State environmental approval processes (i.e. Environmental Impact Assessment pursuant to Part IV of the *Environmental Protection Act 1986*). Scheduled TECs are afforded statutory protection at a Federal level pursuant to the EPBC Act.

A search was undertaken for the study area of CALM's TEC database. The search indicates that there are no known occurrences of TECs recorded within the study area. However, there are occurrences of the 'Critically Endangered' TEC known as '*Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands' and occurrences of the 'Vulnerable' TEC known as 'Herb rich shrublands in clay pans' nearby (within a 5 kilometre radius of the study area). Search results from CALM's TEC database are contained in **Appendix D**.

The Commonwealth EPBC Act promotes the conservation of biodiversity by providing strong protection for TECs. The TEC known as '*Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands' is scheduled under the EPBC Act.

2.2.4 Flora and Vegetation Survey Methods

A botanist from Cardno BSD undertook a Botanical survey on 23rd January 2006. The site was surveyed for flora vegetation communities and condition, Declared Rare Flora (DRF) and Priority Flora and potential areas of TECs. In areas considered to potentially contain TECs, 10 metre by 10 metre quadrats were set up and data recorded to statistically examine the vegetation to determine its likelihood of being considered a TEC. A DRF survey was undertaken by traversing the entire area on foot with transects being parallel and approximately 20m apart.

All plant specimens collected during the flora survey were dried, pressed and then sorted in accordance with the requirements of the Western Australian State Herbarium. Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Nomenclature of species used in this report follows current usage (Western Australia Herbarium 1998-2003).

Aerial photography was used to extrapolate and map plant communities in combination with running notes made during the course of the survey.

2.2.5 Flora and Vegetation Survey Results

2.2.5.1 Recorded Flora

A total of 34 plant taxa, comprising 16 families and 26 genera were recorded in the project area (see **Appendix E**). Species representation was greatest among the Myrtaceae and Papilionaceae families. Three introduced (weed) species were collected. Weeds were abundant in the Poaceae (grasses) and Polygonaceae (Dock) families.

None of the DRF or PF species listed as potentially located on the study area were located during the flora survey. While the survey was not undertaken in Spring (when most of the DRF or PF species would be more likely to be evident), the site has been subjected to continual degrading influences (i.e. stock grazing and trampling) for over 50 years, and it is therefore unlikely that any of the DRF or PF species potentially located in the Bunbury locality would be present.

2.2.5.2 Introduced Species

Eighteen introduced Flora species were recorded on the site. Introduced species (weeds) were recorded in the Poaceae (grass) and Polygonaceae (Dock) families. This represents 53% of the total flora recorded on site.

2.2.5.3 Local Vegetation Communities

Two vegetation communities are represented on the site at a local level. Vegetation Community 1 is the dominant vegetation community within the subject site, and is located on the northern portion of the study area. Community 1 is mostly "Degraded", and remnant native vegetation is represented by large individuals of *Corymbia calophylla, Nuystia floribunda* and *Melaleuca preissiana* with limited understorey. The land in between the tree-lined borders of the northern portion is currently used for grazing and devoid of remnant native vegetation. The pasture areas appear to be covered with introduced weed species associated with pasture or fodder. These weed species have completely replaced the native understorey vegetation over the northern portion of the study area and are common across the Swan Coastal Plain. This vegetation types is best described as Pasture Cleared Marri Woodland. The typical condition of vegetation within this portion of the site is shown in **Plates 15-16**.

Vegetation Community 2 consists of *Eucalyptus rudis* damplands, and this vegetation is mostly in "Good" Condition. This vegetation community is dominant on the southern portion of the study area adjacent to the streamline, and is representative of a transition between the Swan Complex and Guildford Complex, with established *Casuarina obesa, Corymbia calophylla* and *Eucalyptus marginata*, as well as *E. gomphocephala*. Much of the floodplain adjacent to the river has previously been cleared, and is currently used for grazing. The typical condition of Vegetation Community 2 within the southern portion of the study area, and adjacent to the Collie River is shown in **Plates 17-18**.

Vegetation Communities observed onsite are summarised below in **Table 2.2.5.3.**

Table 2.2.5.3: Local Vegetation Communities Recorded at Roelands – January 2006.

Mapping Code	Community Descriptions
Vegetation Community 1 – Pasture cleared Marri woodland	
1	Open woodland of *Eucalyptus marginata, Corymbia calophylla.*
Vegetation Community 2 – *Eucalyptus rudis* damplands	
2	*Open woodlands of Eucalyptus rudis and Casuarina*

2.2.5.4 Regional Vegetation Communities

Species recorded within each vegetation community were compared with species occurring in the Gibson *et al.* (1994) database of vegetation communities on the southern Swan Coastal Plain using the vegetation significance methodology described below. The inferred Floristic Community Type (FCT) is based on the number of species matches and is recorded in **Table 2.2.5.4** below.

Table 2.2.5.4: Inferred Gibson *et al.* Floristic Community Type

Vegetation Community Code	Floristic Community Type
1	3b
2	13

Two Gibson *et al.*, (1994) FCT's have been recorded on site – Vegetation Community 1 is most similar to FCT 3b *Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils. Vegetation Community 2 is most similar to FCT 13 '*Deeper wetlands on heavy soils*'. Vegetation communities found on the study area are shown in **Figure 4**.

FCT 3b is described as *Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils and appears throughout the southern part of the Swan Coastal Plain. FCT 3b has been recorded along the coastal plain from Pinjarra to Busselton and the Gibson *et al.* site descriptions reflect the vegetation occurring on site. FCT 3b is recorded as having a "Vulnerable" conservation category by Gibson *et al.* (1994), and is currently listed as a "Vulnerable" TEC by CALM, however it is not protected under the EPBC Act. The current vegetation predominately consists of over storey with limited understorey species and therefore does not provide a true representation of FCT 3b. This is largely due to historic degradation and grazing of the northern portion of the study area.

FCT 13 is described as 'Deeper wetlands on heavy soils' and appears throughout the southern part of the Swan Coastal Plain. FCT 13 has been recorded along the coastal plain from Pinjarra to Busselton and the Gibson *et al.* site descriptions reflect the vegetation occurring on the southern portion of the study area. FCT site 13 is well-reserved community type in a low risk category in accordance to its conservation status (Gibson *et al* 1994).

2.2.5.5 Vegetation Condition

The Vegetation Condition was rated according to the Vegetation Condition Scale commonly used in the Perth Metropolitan Region (Government of WA, 2000). In general, the vegetation condition ranged from "Very Degraded" to "Good". The majority of the area has been parkland cleared and therefore retained little to no structure and native species. Areas of "Good" vegetation occur within Vegetation Community 2, along foreshore areas of the river. Vegetation condition mapping has been prepared based on field observations made during the flora survey and with current aerial photography and is shown in **Figure 5**.

2.3 ENVIRONMENTALLY SENSITIVE AREAS

Environmentally Sensitive Areas (ESAs) are areas that cannot be cleared under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. These have been identified in order to protect the native vegetation values of areas surrounding significant, threatened or scheduled ecosystems or communities. The DOE's database of ESAs (DOE, 2006) indicates that the study area includes all or portions of three ESAs. These ESAs are consistent with the locations (or portions thereof) of wetland #1733 (including a 50m buffer), and the 1992 EPP boundaries of wetland #1869, and the 'sumpland' within wetland #1736 (see **Section 2.5** for wetland descriptions). ESAs within the study area are shown in **Figure 6**.

2.4 HYDROLOGY

2.4.1 Groundwater

Predicted groundwater levels were not available for the study area from the Perth Groundwater Atlas, however the Department of Environment (DOE) provided records from monitoring bores and nearby private bores. One of the monitoring bores (AWRC ref HS73A) was located within Lot 3315. The elevation of the DOE monitoring bore is approximately 16m AHD, and its location is shown in **Figure 3**. Records for the previous 18 years were available for this location. The records indicate that the water table varies in elevation from 7.7m AHD to 9.8m AHD. Given that the base of the streamline located on the southern border of the site has an elevation of between 0-2m AHD, and that there are no significant areas of groundwater discharge or recharge between the Collie River/adjacent wetlands and the bore site, it can be inferred that the groundwater levels between these locations slope from 10m AHD to 0-2m AHD with the hydraulic gradient running in an north-south orientation towards the Collie River/adjacent wetlands. This would indicate a minimum depth to groundwater underlying the northern portion of the study area of approximately 6m.

A number of test-pits were excavated on the study area to a depth of 2-4 metres to observe the soil profile, collect soil samples and observe the soil moisture content (see **Section 2.1.4**). While the soils at some locations were observed to be slightly moist the watertable was not encountered, suggesting that the depth to water is greater than three metres. However, the presence of mottled grey clay soils at varying depths (0.7-2.7m) across the study area suggests that localised winter groundwater levels may be perched above the low permeability clay layers.

2.4.2 Surface Water

As indicated previously, the study area is bordered by the Collie River and Collie River floodplain. Anecdotal evidence provided by the current landowner (who has owned the site for approximately 50 years) indicates that the floodplain becomes inundated every 10-12 years, usually in years when the Wellington Dam overflows. The extent of the Collie River floodplain in the vicinity of the study area is denoted within the *Swan Coastal Plains Geomorphic Wetlands* dataset as wetland #1736. The extent of the floodplain based upon this data is shown in **Figure 6**. Further data was provided by the Water Corporation regarding historical maximum flood levels within the Collie River in the vicinity of the study area, at the confluence of with Henty Brook. This data indicates that the maximum recorded flood level at this location was approximately 5mAHD. This level has been used to determine the approximate extent of the Collie River floodplain within the study area. The previously recorded floodplain of the Collie River is generally consistent with the data provided by the Water Corporation, with the exception of the hill located on the northeastern corner of Lot 314. The hill on the northeastern corner of Lot 314 has an elevation of up to 10m AHD, and is unlikely to be inundated given that the historical maximum recorded level of the Collie River in proximity to the study area is 5m AHD.

There are three wetlands located within the study area that support permanent water, and these are described in in further detail in the following Section.

2.4.3 Wetlands

Wetlands on the Swan Coastal Plain have previously been previously been classified by the former Water and Rivers Commission (WRC) and detailed within the Swan Coastal Plains Geomorphic Wetlands dataset. The Swan Coastal Plain Geomorphic wetlands dataset indicates that the entire study area is classified as a group of wetlands or part thereof. The details of the wetlands, as provided within the dataset are as follows:

- A portion of a large (10,150ha) 'palusplain' Multiple Use Wetland (MUW) (wetland ID # 13240);
- A portion of a 347ha 'floodplain' that has been evaluated as MUW (wetland ID #1736);
- A 5.9ha 'sumpland' that has been evaluated as Resource Enhancement Wetland (REW) (wetland ID #1869);
- A 2.8ha 'sumpland' that has been evaluated as MUW (wetland ID #1718);
- A portion of a 8.6ha 'floodplain' that has previously been evaluated as Conservation Category Wetland (CCW) (wetland ID #1733).

These wetlands are shown in **Figure 6** and are further described in the following sections.

2.4.3.1 Wetland #13240

The majority of the study area, comprised predominantly of the northern undulating plain, is a part of a large 'palusplain' MUW. This area varies in elevation from 18mAHD to approximately 4m AHD where it borders the Collie River floodplain. While this area is classified as a wetland, the underlying landforms are undulating plains, predominantly at an elevation of approximately 16mAHD.

Furthermore, it does not retain any attributes of a wetland and does not support any wetland dependant vegetation. It is therefore considered that the classification of this area being a wetland is not consistent with the observed characteristics of this portion of the study area. The typical condition of the northern portion of the study area is shown in **Plates 15** and **16**.

2.4.3.2 Wetland #1736

The floodplain of the Collie River within the study area is a part of a 347ha 'floodplain' that has been evaluated as MUW. This area has been mostly cleared for grazing, and remnant vegetation is limited to a thin strip of riparian vegetation along the Collie River. The typical condition of the 'floodplain' is shown in **Plates 17** and **18**. The entire floodplain area was observed to be currently utilised for grazing. Given the degraded condition of the floodplain area, it is considered that the MUW management category is appropriate. There is another approximately 3ha area located within the Collie River floodplain, that was not specifically identified within the Geomorphic Wetlands dataset, and this area appears to be have characteristics consistent with a 'sumpland' wetland. This 'sumpland' wetland area is completely devoid of overstorey species, and has limited sedges and rushes that appear to have been impacted by stock grazing and trampling. The wetland does not retain any native vegetation buffer. The typical condition of the 'sumpland' is shown in **Plate 19**.

The 'sumpland' wetland area is included within the EPA's *Environmental Protection (Swan Coastal Plain Lakes) Policy* (EPP) *1992* (EPA, 1992), and as such is afforded statutory protection from various acts or activities. However close inspection of the boundaries of the wetland as included within the 1992 EPP reveal that the boundaries do not coincide with the on-ground location of the wetland. Given that the positional accuracy of the 1992 dataset is +/- 100m it can safely be assumed that the mapping resolution utilised for creation of the 1992 dataset does not accurately depict the wetland's location. This is confirmed by inspection of the *Revised Draft Environmental Protection Policy (Swan Coastal Plain Wetlands) Policy 2004* (EPA, 2004), in which the location of the revised wetland boundaries is approximately 100m to the south of the 1992 EPP boundaries.

2.4.3.3 Wetland # 1869

Within the floodplain area a 5.9ha 'sumpland' is located immediately adjacent to the Collie River floodplain (though it is effectively a part of the floodplain) that has been evaluated as REW. This wetland is also known as 'Shag Swamp', and has a dense overstorey and relatively intact understorey, though the edges of the wetland appear to have been degraded by stock grazing and weed infestations. The condition of this wetland is shown in **Plate 20**. Given the density of overstorey vegetation, though reduced understorey, it is considered that the currently assigned management category is appropriate.

Wetland #1869 is also protected under the 1992 EPP, however similar spatial boundary issues exist to those detailed for wetland #1736. Close inspection of the boundaries of wetland #1869 as included within the 1992 EPP reveal that the boundaries do not coincide with the on-ground location of wetland #1869. Given that the positional accuracy of the 1992 dataset is +/- 100m it can safely be assumed that the mapping resolution utilised for creation of the 1992 dataset does not accurately depict wetland

#1869's location. This is confirmed by inspection of the *Revised Draft Environmental Protection Policy (Swan Coastal Plain Wetlands) Policy 2004* (EPA, 2004), in which the location of wetland #1869 boundaries are approximately 100m to the south of the 1992 EPP boundaries.

2.4.3.4 Wetland # 1718

A further 'sumpland' is immediately adjacent to (though effectively encompassed by) the floodplain, being a 2.8ha MUW. This wetland is completely devoid of overstorey species, and vegetation is limited to degraded sedges and rushes. The sedges and rushes appear to have been degraded due to the influence of stock grazing and trampling. The wetland does not retain any surrounding vegetative buffer. The condition of this wetland is shown in **Plate 21**. Given the degraded condition of the floodplain area, it is considered that the MUW management category is appropriate.

2.4.3.5 Wetland # 1733

Immediately adjacent to Wetland #1718 is a 7.8ha CCW that is recorded as being 'floodplain'. The majority of the CCW does not fall within the study area, however a small portion (0.3ha) lies within the boundary of Lot 121. The portion of the CCW that does lie within Lot 121 consists of a few isolated overstorey species, and does not appear to support any native understorey. The CCW and a 50m buffer are recorded as being an ESA (DOE, 2006). The majority of the CCW was not assessed during this study, and therefore no evaluation is made as to how appropriate the current management category is.

2.5 THREATENED FAUNA AND FAUNA HABITAT

CALM's Threatened Species List contains two species that could potentially occur on the study area, namely the Western Ringtail Possum (*Pseudocheirus occidentalis*) and the Peregrine Falcon (*Falco peregrinus*). The Western Ringtail Possum is known to occur in areas of *Agonis flexuosa* woodland and requires tree hollows and/or dense canopy for refuge and nesting. As the majority of the site has been cleared, and remnant vegetation across the majority of the site is limited to large established trees along pasture borders, it is unlikely that this species would be present on the site. The Peregrine Falcon is uncommon, and prefers areas with rocky edges, cliffs, watercourse, open woodland or margins with cleared land. It is therefore possible that this species could be an occasional visitor to the study area. Search results of the CALM Threatened Fauna database are contained in **Appendix F**.

The general fauna habitat value of the southern (floodplain) portion of the study area that contains the Collie River and adjacent floodplain could be considered to be moderate. This is due to the presence of some individuals of *Agonis flexuosa* along the shoreline of the Collie River, although there were only several individuals of this species noted. The habitat value of the remainder of the floodplain area is higher than would be expected for an area subjected to the extent of historical clearing and subsequent grazing of the study area. This is due to the presence of Wetland #1869 being located on the floodplain. The core of Wetland #1869 is largely undisturbed, a dense cover of understorey species and retains some dryland buffer with a number of mature trees, and could therefore potentially provide habitat for a number of species. Vegetation within Wetland #1718 consists of sedges and

rushes, while vegetation within the small portion of the CCW within Lot 121 is limited to a few mature trees.

Fauna habitat values associated with the northern portion of the study area have been severely reduced by the historic clearing of native vegetation. The few remaining larger trees in this portion of the study area are within a degraded habitat, being predominantly situated on the property and access road borders. It is therefore unlikely that habitat for any of the above species will be affected by its development.

It is not considered that the northern portion of the study area would provide a significant wildlife corridor function, as it is a largely cleared site, located amongst similarly cleared grazing land with no significant areas of remnant vegetation nearby. However, the riparian vegetation fringing the Collie River and wetland #1869 are likely to provide some corridor/drought refuge functions, and impacts to these areas should be avoided.

2.6 ETHNOGRAPHIC CONSIDERATIONS

2.6.1 Aboriginal Heritage

A search of the Department of Indigenous Affairs (DIA) database of known sites of aboriginal significance (DIA, 2006) indicates that there are no known sites of significance within the study area.

2.6.2 European Heritage

A search of the Heritage Council of Western Australia's database (Heritage Council of WA, 2006) found that no recorded sites of European heritage occur within the study area. The Shire of Harvey's Municipal Heritage Inventory does not list any sites of significance within the study area (Shire of Harvey, 1996).

2.7 HISTORIC AND SURROUNDING LAND USES

2.7.1 Study Area Land Use

The current observed use of the study area is stock grazing of dairy cattle. Anecdotal evidence indicates that stock grazing has been the land use for the at least the last 50 years (*pers comm.* Kevin Moore). Grazing is not an activity that is likely to cause significant soil and/or groundwater contamination of the study area.

There are 132Kv and 66Kv powerlines and associated 32m and 25m easements dissecting the site (see **Figure 7**).

2.7.2 Surrounding Land Uses

The current use of immediately adjacent properties (i.e. north of Treendale Road) was observed to be stock grazing of dairy cattle. Other surrounding land has been developed for 'Special Rural' purposes

(to the east) and for 'Special Residential' purposes (to the west) (Shire of Harvey, 1996). Other land in the general vicinity of the study area (i.e. south of the Collie River and floodplain) is predominantly used for stock grazing, however a minor amount of viticultural use was observed approximately 150m south of the Collie River.

2.8 SUMMARY OF EXISTING ENVIRONMENT

In summary, the investigation into environmental considerations indicates that:

- The study area is composed of two widely differing landforms, being the previously cleared undulating and 'scarp' northern portion and the Collie River Floodplain adjacent to the Collie River;
- Soils underlying the study area are sandy clays with a thin surface horizon of quartz sand of varying depth. Surface soils can be expected to provide reasonable permeability, while subsoils can be expected to generally have a low permeability;
- Onsite investigations indicate that:
    - soils on the northern portion of the site are duplex quartz sand (0.2-0.7m) over dense highly plastic clays. Clays were mottled at depths of 0.7-2.7m, suggesting a seasonal perched watertable at this depth;
    - Soil types underlying the southern floodplain portion of the site were found to be red/brown loamy earth of between 1.2m and 2.7m depth, overlying mottled grey/brown, orange/yellow or red/orange clays. These soils are consistent with those that could be expected to be found within alluvial floodplain areas.
- Soil analysis indicates that the surface soils underlying the northern portion of the study are have a low to moderate nutrient retention capacity;
- Flora values of the northern portion of the study area are minimal, as this area has been cleared and used for pasture. The native vegetation adjacent to the streamline appeared to be in good condition, though understorey species were scarce;
- The Collie River borders the study area to the south and the adjacent Collie River floodplain within the study area contains substantial riparian vegetation;
- A search of CALM's database of DRF and Priority flora indicated that there are no known records for any of these species on the study area;
- A search of CALM's TEC database indicated that there are no known TEC occurrences within the study area;
- Based on DOE information, three ESAs are located within the study area, the locations of which are consistent with a 50m buffer from wetland #1733, the 1992 EPP boundaries of wetland #1869, and the 1992 EPP boundaries of the 'sumpland' that is a part of wetland #1736;
- All available information consulted indicates that the groundwater underlying the northern portion of the study area is at considerable depth (>8m) and that infiltration to groundwater is likely to be very slow to non-existent due to the highly impermeable clays in the soil profile;
- The entire site is classified as mostly wetland under the DOE's Swan Coastal Plain Geomorphic Wetlands dataset. The northern 'palusplain' MUW portion (ID #13240) covers the majority of the site, however it does not exhibit any qualities consistent with the definition of "wetland". The floodplain of the Collie River has been determined to be MUW (ID

#1736). Within the practical extent of the Collie River floodplain there are four wetlands or portions thereof, being a 5.9ha REW that is recorded as being a 'sumpland' (ID #1869), a 2.8ha MUW that is also recorded as being a 'sumpland' (ID #1718), a 0.3ha portion of a larger CCW (mostly situated beyond the boundary of the study area) (ID #1733) and a sumpland that is recorded as being a part of wetland #1736. Two of these wetland areas are protected by the 1992 EPP, though the positional accuracy of the 1992 EPP boundaries may require re-evaluation prior to undertaking ground disturbing activities to verify that the on-ground boundaries (and as recorded in the Revised Draft 2004 EPP) are considered to be accurate;

- A search of CALM's database of database of Threatened Fauna indicated that there are no known occurrences of Threatened Fauna within the study area;
- A search of the DIA database of known sites of aboriginal significance (DIA, 2006) indicates that there are no known sites of significance within the study area;
- A search of the Heritage Council of Western Australia's database (Heritage Council of WA, 2006) found that no recorded sites of European heritage occur within the study area; and
- The site has been historically cleared and has been utilised for the purposes of grazing for over 50 years.

3. PROPOSED FUTURE DEVELOPMENT

The study area is proposed to be re-zoned from '"Rural" to "Special Residential" under the Shire of Harvey District Planning Scheme (DPS) No. 1. The rezoning will include an Outline Development Plan that will further detail the manner in which the site will be developed. Once re-zoned, it is envisaged that the study area will be sub-divided into minimum 2000m^2 parcels. Cardno BSD recommends that the lots should be located predominantly within the northern undulating plain portion of the study area, and that building envelopes are specified such that development does not encroach on any ESAs, floodplain areas or recommended foreshore reserves.

The development will involve the installation of a number of sealed roads, as well as services including reticulated water and power. The development will not be connected to reticulated sewer and will therefore utilise onsite effluent disposal methods (i.e. septic tank and/or Ecomax^{TM} treatment units).

4. ENVIRONMENTAL IMPACTS AND MANAGEMENT

The potential environmental impacts relating to the issues identified within the existing environment are discussed in the following sections.

4.1 LAND CAPABILITY ASSESSMENT

The proposed development will involve the utilisation of onsite disposal of household effluent. Given the proximity of the development to the Collie River, and two EPP wetlands, there is the potential for soluble nutrients to end up impacting on these receiving environments. The extent of the potential for nutrients from effluent disposal to impact these downstream environments is largely a function of the

capability of the land to provide an effluent treatment function and the extent of treatment that will be provided to the effluent by the proposed disposal system.

Land capability refers to the ability of land to support a type of land use without causing damage (Austin & Cocks, 1978). It thus considers both the specific requirements of the land use, plus the risks of degradation associated with the land use. As a general guide for conducting land capability assessments, the evaluation should be carried out based on all available information (van Gool & Moore, 1999). The assessment can be conducted based upon published land resource mapping, however attributed land qualities should be checked against field observations. In this instance, site specific aspects investigated include:

- Test-pitting to determine soil profiles;
- Laboratory analysis of soil samples;
- Visual observation of presence/absence of groundwater in test-pits;
- Research of records from underlying and/or nearby groundwater bores; and
- Anecdotal evidence from surrounding residents and landowners.

4.1.1 Assessment of Land Qualities

The process for conducting a land capability assessment is to first assess the relevant land qualities. It is understood that the building envelopes would not be located within the floodplain area, immediately adjacent to the streamline or within the seasonally inundated swamp (mapping unit P7 and test pit location RL4). Therefore the assessment of land qualities has been limited to the larger, gently sloped northern portion of the study area.

The land capability assessment for septic tanks for rural residential development is intended to cover areas that can be used for soil absorption and purification of septic tank effluent. It is understood that the proposed development will utilise Ecomax™ treatment units, rather than traditional septic tank effluent disposal systems. The treatment requirements for septic tank effluent disposal systems are substantially more extensive than is required for Ecomax™ treatment units, therefore the land capability assessment can be considered to be a conservative assessment.

The land qualities important to onsite effluent disposal within developments include:

- Waterlogging;
- Microbial purification ability;
- Land instability;
- Ease of excavation; and
- Flood risk.

The assessment of each of these qualities results in a rating being assigned to each land quality of 'nil' (N), 'very low' (VL), 'low' (L), 'moderate' (M) or 'high' (H) and is further detailed below.

4.1.1.1 Waterlogging

Waterlogging is excessive water in the root zone accompanied by anaerobic conditions. The excess water inhibits gas exchange with the atmosphere and biological activity uses the available oxygen and photosynthesis is impaired. Field inspections were carried out in January, and while the underlying clay soils were observed to be moist, they did not appear to be saturated. While the majority of the northern portion of the study area is not subject to inundation, it appears that it may have a seasonally perched watertable at a depth of 0.7-2.7m based upon the depth of mottled clays within the soil profile. According to the current landowner, some parts of the northern portion of the study area remain green longer than others (*pers. comm.* Kevin Moore), further suggesting the presence of a perched watertable in some areas.

Given that the test pitting was undertaken in January 2006, and that groundwater levels generally peak around October-November each year, it can be assumed that the groundwater level observed is 2-3 months beyond the seasonal peak. The groundwater underlying the northern portion of the site is therefore likely to be perched for less than 4-6 months per year. Therefore, the majority of the northern portion of the site can be considered to have a 'high' to 'moderate' waterlogging rating.

4.1.1.2 Microbial Purification Ability

Microbial purification relates to the ability of the soil used for septic effluent disposal to remove microorganisms that may be detrimental to public health. It is essentially a measure of the permeability and aeration within the soil profile, which influences its ability to remove undesirable micro-organisms from septic effluent and provide suitable conditions for the oxidation of some organic and inorganic compounds added to the soil as effluent.

The northern portion of the study area surface soil properties consist of medium to fine grained coloured quartz sands and have a depth to the poorly structured clay layer of 0.4m to 0.7m. Therefore, the study area can be considered to have a 'very low' microbial purification rating.

4.1.1.3 Land Instability

Land instability assesses the potential for rapid movement of a large volume of soil. This includes mass soil movement through slope failure, shifting sand dunes, wave erosion and subsidence in karst topography (land underlain by caves). Factors that need to be considered include the slope of land, presence of through-flow, geological features such as attitude of bedding planes relative to slope, rock fracture and shear zones, topographic features such as proximity to cliff or scarp faces and climatic features such as the susceptibility to groundwater saturation.

The northern portion of the study area has a slope of between 0% and 27% (maximum of approximately 17%) and would shed water readily and given that significant seepage or through flow is unlikely due to the underlying clay soils, this portion of the site can therefore be considered to have a 'very low' land stability hazard.

4.1.1.4 Ease of Excavation

The ease of excavation refers to the ease with which soil can be excavated for building construction or earthworks, commonly at depths ranging from 0.3m to 1.5m. These earthworks relate to activities such as levelling of building sites, installation of septic tanks and leach drains and shallow excavations for building foundations.

As the depth to rock is greater than 1.5m, the maximum slope is approximately 17%, there is <20% stone (laterite gravels) within the soil profile, no rock outcrops and a 'high' waterlogging risk, the study area is considered to have a 'moderate' ease of excavation.

4.1.1.5 Flood Risk

Flooding is the temporary covering of land by moving water from overflowing streams and runoff from adjacent slopes. As the northern portion of the study area is elevated and can be considered to have a 'nil' flood frequency return interval, the study area can be considered to have a 'nil' flood risk rating.

4.1.2 Land Capability Assessment

The land capability assessment has been conducted consistent with the guidelines for assessing land qualities and determining land capability in south-west WA produced by the Agriculture Department of WA (AGWA) and detailed in the document *Land Evaluation Standards for Land Resource Mapping* (van Gool & Moore, 1999). Key inputs for the capability assessment are the published *Land Resource Mapping for Harvey to Capel on the Swan Coastal Plain Western Australia* (Barnesby & Proulx-Nixon, 1994) and the site characteristics determined through site inspection, soil test pitting and soil analysis.

Once the land qualities have been assessed, these can be compared against the AGWA produced land capability tables (van Gool & Moore, 1999). These tables allow a standard assessment to be carried out based upon interpretation of land capability resource mapping and site-specific investigations. The land capability table for septic tanks for rural residential development is shown in **Table 4.1.2.1**, with land qualities (as determined above) being shown shaded.

Table 4.1.2.1 Land Capability for Septic Tanks for Rural Residential Developments (van Gool & Moore, 1999).

Land Quality	Land Capability Class				
	1	2	3	4	5
Water logging	N, L, VL		M	H	VH
Microbial Purification	H	M	L	VL	
Land Instability	N	VL	L	M	H
Ease of Excavation	H	M	L	VL	
Flood Risk	N		L	M	H

The land capability class is then determined by the most limiting land quality. The five capability classes commonly utilised are shown in **Table 4.1.2.2** (adapted from Wells & King, 1989).

As indicated previously, it is highly recommended that the building envelopes are not located within the steeply sloped easternmost portion of the study area (immediately adjacent to the streamline) due to the environmental (see **Section 2**) and policy (see **Section 4.1.4**) constraints associated with this portion of the lot. Therefore the assessment of land qualities and subsequent land capability assessment has been limited to the larger, gently sloped western portion of the study area.

Table 4.1.2.2 Land capability classes for given land-use types.

Capability Class	General Description
1- Very high	Very few physical limitations present and easily overcome. Risk of land degradation is negligible.
2 – High	Minor physical limitations affecting either productive land use and/or risk of degradation. Limitations overcome by careful planning.
3 – Fair	Moderate physical limitations significantly affecting productive land use and/or risk of degradation. Careful planning and conservation measures required.
4 - Low	High degree of physical limitation not easily overcome by standard development techniques and/or resulting in high risk of degradation. Extensive conservation measures required.
5 – Very low	Severe limitations. Use is usually prohibitive in terms of development costs or the associated risk of degradation.

In this case the land capability for septic tanks for rural residential development of Lots 121, 246, 314 & 3315 Treendale Road, Roelands is limited by the 'very low' microbial purification ability, and 'high' waterlogging risk, giving a land capability class of '4'. A land capability class of '4 - low' indicates that the study area has a high degree of physical limitation not easily overcome by standard development techniques and/or development could result in high risk of degradation. In the case of sites that have a low land capability, extensive conservation measures may be required in order for the development to proceed. On this basis it is recommended that septic tanks are not proposed for effluent disposal. It is recommended that Ecomax™ treatment units that utilise inverted installation leach drains be utilised to address low microbial purification ability and high waterlogging risk.

Given that Ecomax™ units are proposed to be utilised for effluent disposal, the study area can be considered to have a '2 - high' capability for residential subdivision, with the limiting factors being a 'moderate' ease of excavation and 'very low' land instability. A land capability class of '2' indicates that there are only minor physical limitations that can be overcome by careful planning. The inverted installation of Ecomax™ units is further detailed below.

Given the highly impermeable soils under the northern portion of the study area (the area that would most likely be developed), and the high nutrient retention ability of the clay soils (see **Section 2.1**) it is unlikely that the Collie River will be impacted by migration of nutrients through groundwater. As the soils are highly impermeable, soluble nutrients would be more likely to be mobilised by surface runoff than percolate to groundwater.

4.1.3 Ecomax Effluent Treatment Units

Ecomax ™ treatment units are an alternative treatment effluent system that utilises two cells used in rotation. A large part of the treatment process occurs during the effluent flow through the cell and subsequently through the amended soil medium within which the leach drains are installed. The treatments that are applied to effluent water through the Ecomax™ system include a number of treatment processes during the flow through cell, including filtration, pH adjustment, ion exchange, specific adsorption, precipitation, nitrification/denitrification, detention and evaporation or dilution.

The system can be utilised in areas of high groundwater and/or impermeable soils through an 'inverted installation'. An inverted installation involves the use of an impermeable liner and amended sand medium underlying and surrounding the leach drains. In these instances the maximum elevation above ground level is 600mm, though this can be reduced where localised soil conditions permit.

Ecomax™ units have been granted approval for their installation in high groundwater and/or impermeable soil conditions from the Health Department of Western Australia. The approval from the Health Department of Western Australia is shown in **Appendix G**. Given that Ecomax ™ units have been approved by the Health Department of Western Australia, and that when installed using an 'inverted installation' they will address the two issues of concern identified in the land capability assessment (microbial purification ability and waterlogging risk), it can safely be said that the use of these units would be appropriate for the proposed development.

4.1.4 Effluent Disposal Policy

Guidance on the use of on-site effluent disposal methods for Residential developments is provided from a number of government agencies, including:

- The Health Department of Western Australia;
- The Shire of Harvey; and
- The Environmental Protection Authority.

4.1.4.1 Health Department of WA

The Health Department of Western Australia has responsibilities under the *Health Act 1911* to approve on-site effluent disposal system types and provide advice generally on on-site effluent disposal systems. As indicated above, the Health Department of Western Australia has approved Ecomax™ treatment units for high watertable and/or impermeable soil conditions. Indicative guidelines for lot sizes and setbacks to protect the environment are in the *Draft Country Sewerage Policy* (Health Department of Western Australia *et al*, 1999). The Policy provides guidance to statutory authorities, local government and the development industry about sewerage requirements at subdivision and development stages.

The Policy indicates that proposals for large lot subdivision or density development can be considered if they do not involve creation of lots less than 2000m^2, provided that the statutory authority is satisfied that there is no opportunity within the area covered by the proposal for further subdivision without sewerage. Proposed lot sizes range from just over 2000m^2 to over 7000m^2.

Other requirements detailed in the Policy that apply as a minimum in all locations include:

- The wastewater disposal site should not be subject to inundation or flooding at a probability greater than once in 10 years;
- No wastewater system shall be constructed so that effluent or liquid wastes will be discharged into the ground at a distance less than 30 metres from any well, stream or private water supplies intended for consumption by humans;
- No wastewater system shall be constructed so effluent or liquid waste is discharged into the ground within 6 metres of any subsoil drainage system or open drainage channel; and
- Setbacks, groundwater clearance and installation requirements of systems other than conventional septic tank systems shall comply with any particular requirement relevant to the particular system.

4.1.4.2 Shire of Harvey

Domestic wastewater systems are controlled under the *Health Act 1911* and *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974*. The Shire of Harvey administers application and issue of approval to install domestic wastewater systems within the Shire. Communication with the Shire has confirmed that while the Shire has no specific published policy relating to minimum lot sizes and foreshore setbacks, the District Planning Scheme (DPS) No.1, specifies that current minimum lot sizes within 'Special Residential' areas should be no less than 4000m^2 (*pers comm.* Jake Davidson). However, the Shire of Harvey's Draft Local Planning Strategy indicates that future developments within 'Special Residential' areas may be allowed from 2000m^2. Therefore, and amendment to the DPS would need to be sought to facilitate the proposed development of the study area.

4.1.4.3 Environmental Protection Authority

The Environmental Protection Authority (EPA) has published guidelines for on-site effluent disposal. These are documented in *Guidance Statement No.33 Environmental Guidance for Planning and Development* (EPA, 2005).

The document states that:
"On-site effluent disposal is considered to be a practical option for new development areas only where residential densities or the number of systems will remain low, and connection to reticulated sewerage is not feasible."

The Guidance Statement recommends that the environmental requirements in the *Draft Country Sewerage Policy* (see **Section 4.1.4.1**) are taken into account, and that sufficient site-specific studies are carried out early in the planning process to demonstrate that the development will be carried out in a way that is consistent with the environmental objectives and criteria for the receiving environment. It is considered that the second recommendation has been addressed by the information provided in this report.

The Guidance Statement recommends that management measures to ensure that acceptable environmental outcomes occur take into account:

- The density of development and minimum lot sizes;
- The specific location of building envelopes;
- Setbacks for onsite effluent disposal systems/building envelopes from environmentally sensitive areas; and
- Other requirements to ensure on-site systems achieve the desired environmental objectives.

Further setback requirements are applicable for developments within Public Drinking Water Source Areas and ESAs, and as indicated in **Section 2.3** there are portions of the study area that are recorded as being ESAs.

4.2 ACID SULFATE SOILS

As indicated in **Section 2.1.3**, the soils underlying the study area have been rated as having a moderate to low risk of actual ASS or potential ASS at depths of greater than 3m. As excavations on the site are likely to be limited to shallow services (e.g. power and water), road sub-base and low density housing footings, it is not anticipated that there will be significant potential to disturb ASS. Therefore no specific management measures are proposed to address ASS risk.

4.3 FLORA AND VEGETATION

Site specific investigations indicate that the majority of the site is in a 'Very Degraded' condition. In order to prevent further degradation of the flora values of the site it is recommended that the remnant vegetation (i.e. isolated mature paddock trees) within these areas be retained wherever possible.

As there is little remnant vegetation remaining on the northern portion of the study area, and what does remain has become degraded, it is unlikely that any DRF or Priority Flora are present in this portion of the study area.

The vegetation located along the shoreline of the Collie River, and within wetland #1869 was assessed to be in a 'Good' condition. In order to provide protection for the riparian vegetation, it is recommended that the vegetation within these areas should be protected within a 30m wide Foreshore setback. It is recommended that areas that are indicated as foreshore setbacks, EPP wetlands or ESAs are encompassed within a Foreshore Reserve, and that these areas are not included within lot boundaries, and will either be reserved for Public Open Space (POS) or conservation reserves. Provided the recommended Foreshore Reserve is adopted, it is not anticipated that there will be any significant impacts to the flora values of the study area.

None of the DRF or PF species listed as potentially located on the study area were located during the flora survey, however it should be noted that at least two of the Priority species listed as potentially occurring within the study area (*Rhodanthe pyrethrum* (P3) and *Stylidium longitubum* (P3)) October to December flowering annuals that prefer clay pan areas, and are therefore unlikely to be observed during January. It is therefore recommended that a comprehensive flora survey be conducted in late

spring to ensure that none of the DRF or Priority species potentially occurring on the site are present prior to commencement of site clearing.

While the development concept plan is at this stage not finalised, it is anticipated that some of the floodplain area may be included within lot boundaries. It is recommended that building envelopes should not be located within the low-lying (floodplain) portions of the study area in order to maintain the flood conveyance functions of the floodplain and to protect private infrastructure.

Given that building envelopes would not be located within the Collie River floodplain, and that remnant vegetation within the northern portion of the site will be retained wherever possible, it is not anticipated that there will be any significant impacts to the flora values of the study area. It is recommended that the streamline and wetland areas should undergo some form of restoration works to improve their value as POS and conservation reserves, and therefore the flora values of the study area are likely to be enhanced, rather than impacted, as a part of the proposed development.

4.3.1 Collie River Foreshore Management

The Western Australian Planning Commission (WAPC) *Development Control Policy 2.3 Public Open Space in Residential Areas* indicates that a development setback of 30m from waterways is generally required. The EPA also provides guidance with regard to Foreshore Reserves in *Guidance Statement No.33 Environmental Guidance for Planning and Development* (EPA, 2005). The Guidance Statement refers to the document *Determining Foreshore Reserves* (WRC 2001), which recommends an assessment of biophysical features of a waterway to determine an adequate foreshore reserve. The biophysical factors that should be considered include vegetation, hydrology, soil type, erosion, geology, topography, function, habitat, climate, land use and heritage.

By definition, the extent of the waterway includes the floodplain, and therefore any foreshore reserve would normally be determined from the boundary of the 100 year floodplain. The floodplain is 10-300m wide, and the upper boundaries are defined by steep slopes where it adjoins the northern undulating plain (at an approximate elevation of 5mAHD). However, the vegetation structure of the floodplain has historically been substantially changed (through clearing) and the hydrological regimes have also been altered (through upstream damming of the Collie River) to the point where the floodplain now serves an occasional flood conveyance function, but supports negligible riparian and wetland vegetation values.

The location of two EPP wetlands along the northern extremity of the floodplain and a minor portion of a CCW predominantly located to the west of the study area would suggest that a 50m buffer/development setback surrounding these wetlands would be appropriate.

The development of 'Special Residential' areas does not require provision for POS, and therefore a Foreshore Reserve is generally not required. However, the above policies and guidelines should be used to guide placement of the building envelopes to provide adequate protection for the streamline and riparian vegetation and to ensure maintenance structural integrity of future residences.

Based upon the environmental assessment discussed in **Section 2**, a foreshore setback of approximately 30m from the extent of the riparian vegetation is recommended in order to protect the flora values of the Collie River floodplain within the study area, and a Building Envelope Exclusion Area encompassing the entire Collie River floodplain and EPP wetlands is recommended in order to protect the flood conveyance functions of the Collie River floodplain. It is therefore recommended that protection of riparian vegetation, wetland vegetation and overall site flora values is achieved through the use of a designated Foreshore Reserve that encompasses the 30m foreshore setback, 50m EPP wetland buffers and ESAs. The recommended Foreshore Reserve and Building Envelope Exclusion Area are consistent with *Guidance Statement No. 33* (EPA, 2005), WAPC Policy DC 2.3, and the buffer distances required for EPP wetlands. It is recommended that the Foreshore Reserve be given up to the Shire by the developer at the time of subdivision. Building Envelope Exclusion Areas are suitable for inclusion within private lot boundaries, but it is not recommended that building envelopes are located in these areas. The recommended Foreshore Reserve and Building Envelope Exclusion Areas are shown in **Figure 7**.

Furthermore, it is recommended that a Foreshore Management Plan (FMP) be developed for the site at the time of subdivision to ensure that appropriate measures are in place to ensure that any restorative works carried out achieve an improvement in the overall flora values of the site.

4.3.2 Wetlands

As described in **Section 2.4**, within the southern portion of the site (i.e. the Collie River floodplain) contains three wetlands. Two of these wetlands are afforded statutory protection by the 1992 EPP. However, the boundaries of the wetlands and their buffers are not consistent with the actual on-ground location of the wetlands. The location of the wetlands was revised within the 2004 Revised Draft EPP, which is consistent with the on-ground locations of the wetlands. Given that the 2004 Revised Draft EPP is still in draft form, and that the 1992 EPP wetland boundaries are therefore the statutorily protected area, it is recommended that a re-evaluation of the wetland boundaries should be sought through the EPA prior to undertaking ground disturbing activities. Further, it is recommended that a 50m buffer around both Revised Draft EPP wetland locations is adopted.

The current proposal does not involve clearing any of the wetland areas, rather it would involve rehabilitation of the wetland areas where necessary, and restoration of some of the surrounding dryland buffer areas. The restoration of wetland areas should be further detailed in the FMP to be developed for the site at the time of subdivision. The lots and building envelopes proposed as a part of this development will take into account current State and local government policies, and residential development should be limited to areas outside the Foreshore Reserve and Building Envelope Exclusion Area (see **Section 4.3.1**) indicated in **Figure 7**.

Provided that the recommendations regarding the use of a designated Foreshore Reserve and Building Envelope Exclusion Area are adhered to, it is not anticipated that there will be any significant impacts to wetlands within the study area.

4.4 HYDROLOGY

Increasing the proportion of impervious areas within a catchment subsequently increases the volume of stormwater runoff in response to rainfall events. Impervious surfaces that are introduced with residential development include, roofs, driveways, paved areas and roads. Generally, as the density of development increases, so does the proportion of the catchment that ends up being impervious.

Guidance for the management of stormwater quality and quantity is provided to proponents in Western Australia wishing to undertake residential development in the *Stormwater Management Manual for Western Australia* (DOE, 2004). The general principles indicate that in terms of runoff volume, developments should aim to achieve a 'no net increase' to peak flows from storm events.

Given the low density of the development proposed for the site, it is not anticipated that the development will change the existing hydrological response of the study area. Therefore, it is not anticipated that additional runoff will enter the Collie River.

As the building envelopes will be located within the northern undulating plain portion of the study area, and this area is substantially elevated above the wetlands onsite, it is not anticipated that the minor increase in impervious areas due to roof construction will cause significant groundwater recharge or surface flows. Therefore, the potential to impact the hydrology of the wetland areas is considered to be low.

Ideally, drainage of road reserves could be achieved via the use of flush kerbing and will not utilise a piped drainage network. This will allow localised percolation of stormwater runoff into roadside swales. Given the horizontal and vertical separation between roads and wetlands it is not anticipated that the construction of roads will cause any change to the hydrological response of the study area.

The above measures will be further detailed in the Outline Development Plan, to be submitted and approved by the Shire of Harvey as a part of the re-zoning process and then accommodated at the time of subdivision.

4.5 FAUNA HABITAT

As indicated previously, it is recommended that the development of the study area will involve retaining all riparian vegetation, vegetation within wetlands and as much of the remnant vegetation within the northern undulating plain as practically possible. Furthermore, as it is recommended that the riparian vegetation within floodplain will undergo some form of rehabilitation, it is anticipated that the fauna values of the site will increase, rather than decline. Restoration that will be undertaken should be detailed within the FMP to be developed for the site at the time of subdivision.

Given that the fauna habitat of value will be retained within the Foreshore Reserve and Building Envelope Exclusion Area it is not anticipated that there will be any significant impacts to the fauna habitat values of the site.

4.6 HERITAGE

There were no specific Aboriginal or European heritage values identified for the site. However, the Aboriginal Heritage Act 1972 protects sites of Aboriginal significance whether they are know or not. Therefore it is recommended that appropriate measures be taken to ensure that if any materials suspected of being of Aboriginal heritage significance are encountered at the time ground disturbing activities are undertaken. These are likely to include education of contractors as to the potential for archaeological material to be encountered during this time, and cease of works pending further identification should it occur.

4.7 HISTORIC AND SURROUNDING LAND USES

The majority of the land uses identified in proximity to the study area do not require buffer zones from the type of development proposed for the study area. While vineyards may sometimes require buffer zones, the scale of the observed viticulture can be considered to be minor (i.e. single lot). Given the existing separation distance of the vineyard from the study area and the recommended Building Envelop Exclusion Area, it is not considered that an additional buffer between this land use and the proposed development would be required.

5. CONCLUSIONS

The study area is composed of two widely differing landforms, being the previously cleared undulating northern portion and the Collie River and adjacent floodplain. The study area is proposed to be developed for 'Special Residential' purposes.

The soils underlying the site are predominantly sand over clay duplex soils, of varying depths. Topography of the site varies from 18mAHD under the undulating plain to 0-2mAHD within the floodplain of the Collie River. It is recommended that building envelopes should not be located within the seasonally inundated swamp (mapping unit P7 and test pit location RL4) due to the known soil properties of this area which are not readily excavated and are highly impermeable.

The shoreline of the Collie River and wetlands within the Collie River floodplain exhibit significant flora values. These areas also retain fauna habitat values. Furthermore, the floodplain also contains two EPP wetlands, which require buffers to minimise impacts to these areas. The location of proposed building envelopes should therefore take into consideration current state government policies regarding setbacks from wetlands as well as streamlines. Given that building envelopes would not be located within the Collie River floodplain, and that remnant vegetation within the northern portion of the site will be retained wherever possible, it is not anticipated that there will be any significant impacts to the flora values of the study area. Therefore the assessment of land qualities and the land capability assessment has been limited to the larger, undulating northern portion of the study area.

The land capability assessment conducted indicates that the site has a low capability for disposal of effluent via septic tanks. The low overall land capability class was triggered by the 'very low' microbial purification rating, and the 'high' risk of waterlogging. In the case of sites that have a 'low'

land capability extensive conservation measures may be required in order for the development to proceed. The recommended management option to address the low microbial purification ability and high waterlogging potential is to utilise Ecomax™ effluent treatment units which utilise inverted (partially above ground level) leach drains. The Ecomax™ units proposed provide the required microbial treatment function, and have been approved by the Health Department of Western Australia for use in areas with a high watertable or impermeable soils. Given that Ecomax™ treatment units are proposed to be utilised for effluent disposal, the study area can be considered to have a '2 - high' capability for residential subdivision, which indicates that there are only minor physical limitations that can be overcome by careful planning.

The current proposal can be considered to principally comply with the policies and guidelines discussed above, however as the proposed lot sizes are below the DPS No.1 minimum lot size of 4000m^2 within 'Special Residential' areas the Shire should be engaged at an early stage with a view to having the DPS amended as a part of the re-zoning process. Certain provisions should be included within the final subdivision design, including a designated Foreshore Reserve, inclusive of a 30m foreshore setback, EPP wetland buffers and ESAs, and import of fill materials in areas surrounding leach drains to ensure adequate treatment and dispersal of effluent.

5.1 RECOMMENDATIONS

Cardno BSD considers that the general environmental considerations relating to topography, soil, flora, wetlands, fauna and heritage for Lots 121, 246, 314 & 3315 Treendale Road, Roelands do not show characteristics that would preclude development of the majority of the northern portion of the study area for residential purposes.

However, in order for the development to proceed Cardno BSD recommends that:

- Onsite effluent disposal is achieved via the use of Ecomax™ treatment units;
- Measures to encourage adequate infiltration of leach drains are implemented, such as use of impermeable liners and import of amended soil;
- Locations of residential dwellings are within specified building envelopes;
- The development of the study area retains all riparian vegetation, vegetation within wetlands and as much of the remnant vegetation within the northern undulating plain as practically possible;
- The vegetation adjacent to the Collie River should be protected by a 30m wide foreshore setback that extends from the upper edge of the existing riparian vegetation;
- A re-evaluation of the 1992 EPP wetland boundaries should be sought through the EPA prior to undertaking ground disturbing activities;
- A 50m buffer surrounding the locations of the two Revised Draft EPP wetland locations is adopted;
- The streamline and wetland areas undergo some form of restoration works to improve their flora and fauna habitat values;
- A Foreshore Reserve encompassing the 30m foreshore setback, EPP wetland buffer areas and ESAs are physically demarked by a pathway, fence or other suitable method;

- A Foreshore Management Plan (FMP) be developed for the study area at the time of subdivision;
- A Building Envelope Exclusion Area encompassing the entire Collie River floodplain, EPP wetlands and the (P7) seasonally inundated swamp area is adopted;
- Drainage of roads is achieved via the use of flush-kerbing; and
- Appropriate measures are taken to protect any materials suspected of being of Aboriginal heritage significance are encountered at the time ground disturbing activities.

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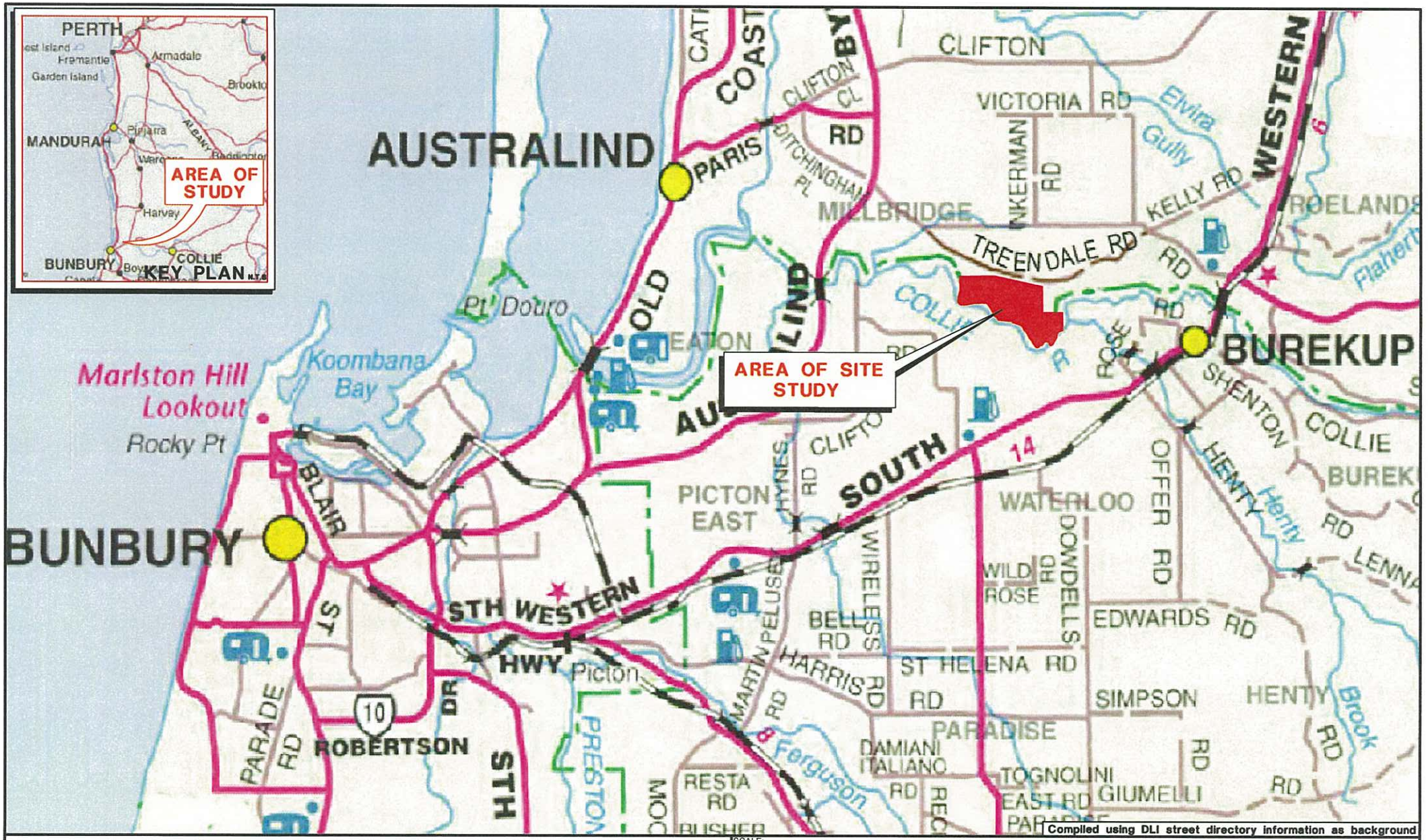
FIGURES



Compiled using DLI street directory information as background

PROJECT **Roelands Environmental Assessment**

DRAWING TITLE **Figure 1: Roelands, Lots 121, 246, 314 & 3315 Locality Map**

PRINCIPAL **Collie River Investments Pty Ltd**

SCALE: **Not to Scale**

N W E S

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Project Number	Drawing Number	Revision	Original
V6003	SK01		A4

Designed MG	Checked DPC	Date	22/02/06
Drawn MG	Approved JDH	Sheet	Of
Local Authority	SHIRE OF HARVEY		

878

TREENDALE ROAD

RL9

RL8

RL5

RL3

RL1

RL6

RL2

RL10

RL7

RL11

RL4

RL12

3

Collie

166

VCL

0

VCL

RL13

River

424

RL14

212

333

209

N

W

E

S

LEGEND

Soil Landscape Mapping Units:

P1a	Flat to gently undulating plain with acidic mottled yellow duplex (or "effective duplex") soils comprising of shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity.
P1b	Flat to gently undulating plain with acidic mottled yellow duplex (or "effective duplex") soils comprising of moderately deep pale sandy loam over clay; imperfectly drained and moderately susceptible to salinity in limited areas.
P7	Seasonally undulated swamps and depressions with very poorly drained variable acidic mottled yellow and grey duplex soils.
P10	Gently undulating to flat terraces adjacent to major rivers, but below the general level of the plain. Deep to well drained uniform brownish sands or loams subject to periodic flooding.
Sw	Miscellaneous swamps

*Note: Source of data from Barnesty & Proulx-Nixon (1994)

RL1 ● Test Pit location

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT: **Roelands Environmental Assessment**

DRAWING TITLE: **Figure 2: Land Units and Test Pit Locations**

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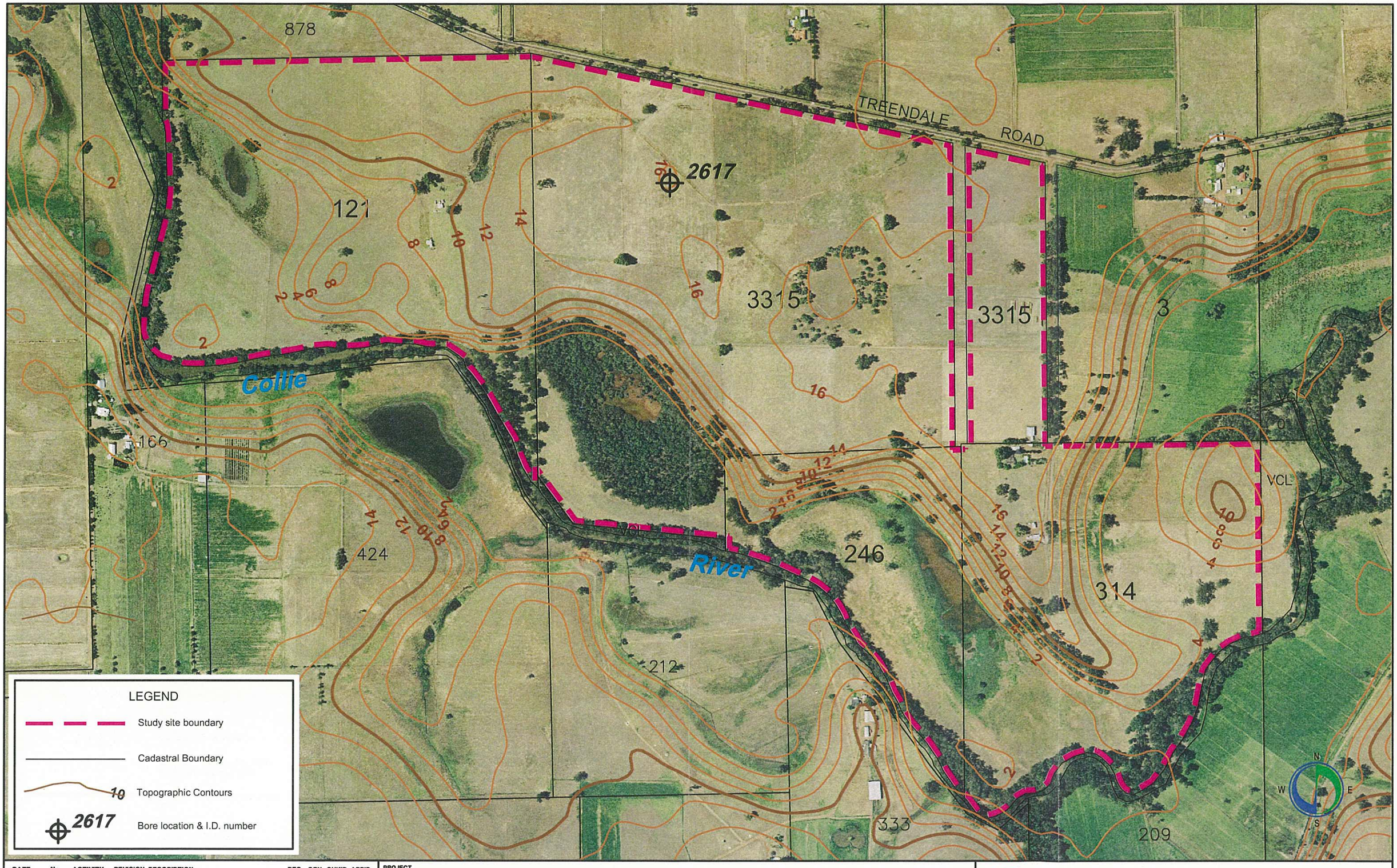

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT: **Roelands Environmental Assessment**

DRAWING TITLE: **Figure 3: Lot Boundaries and Topographic Contours**

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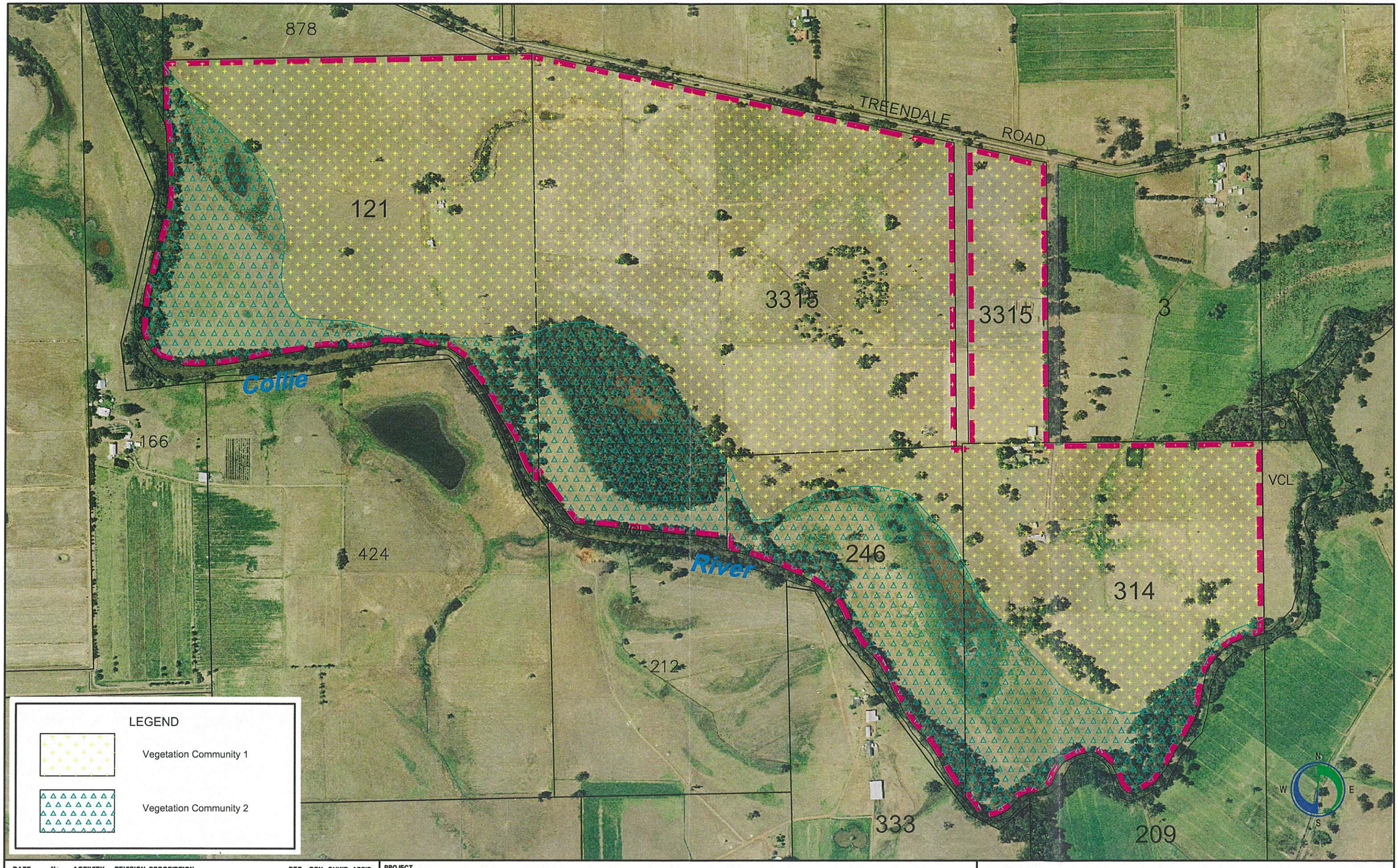

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PROJECT: **Roelands Environmental Assessment**

DRAWING TITLE: **Figure 5: Vegetation Communities**

PRINCIPAL: **Collie River Investments**

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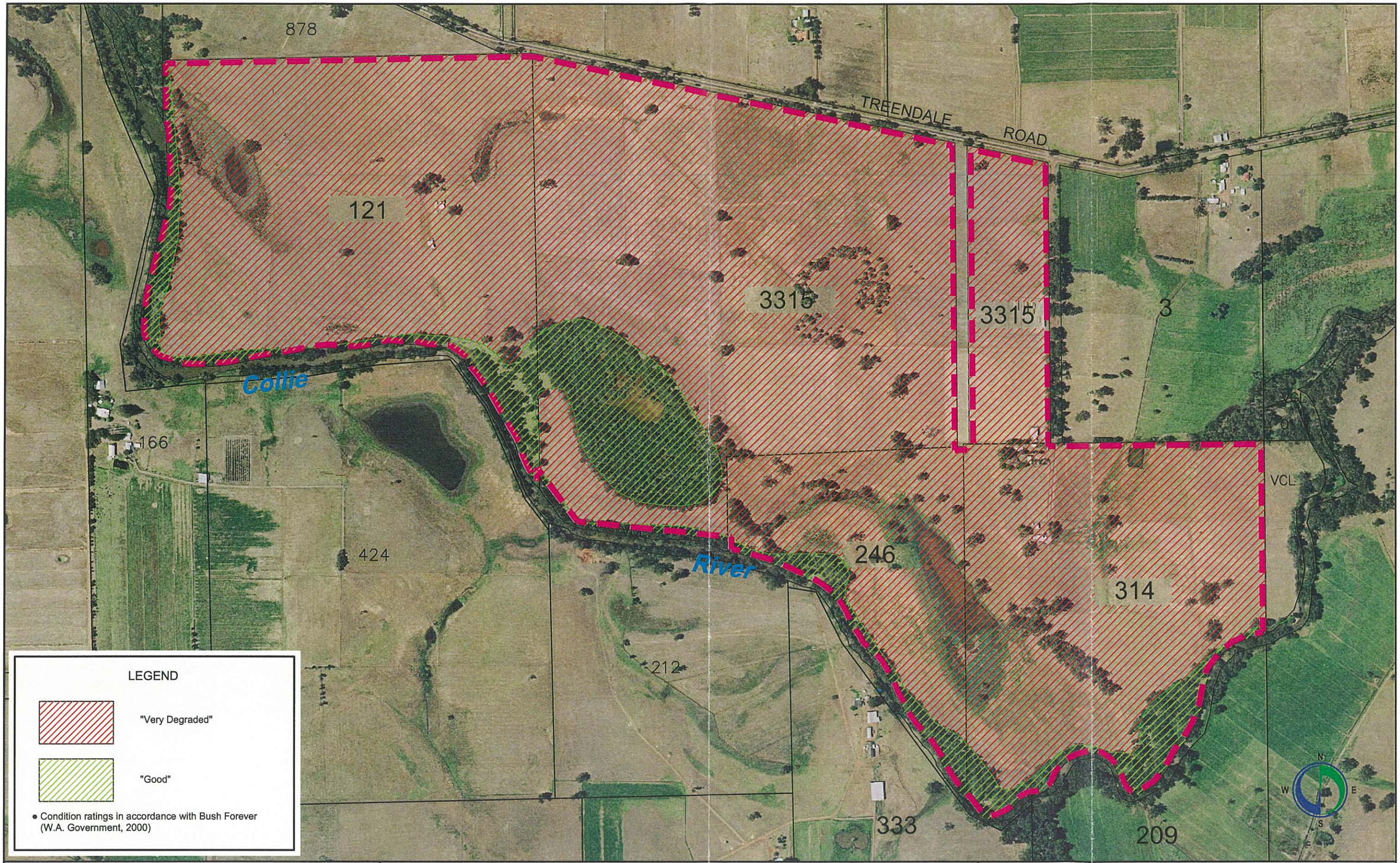

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT: **Roelands Environmental Assessment**

DRAWING TITLE: **Figure 6: Vegetation Condition**

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Project Number V6003	Drawing Number SK06		Revision

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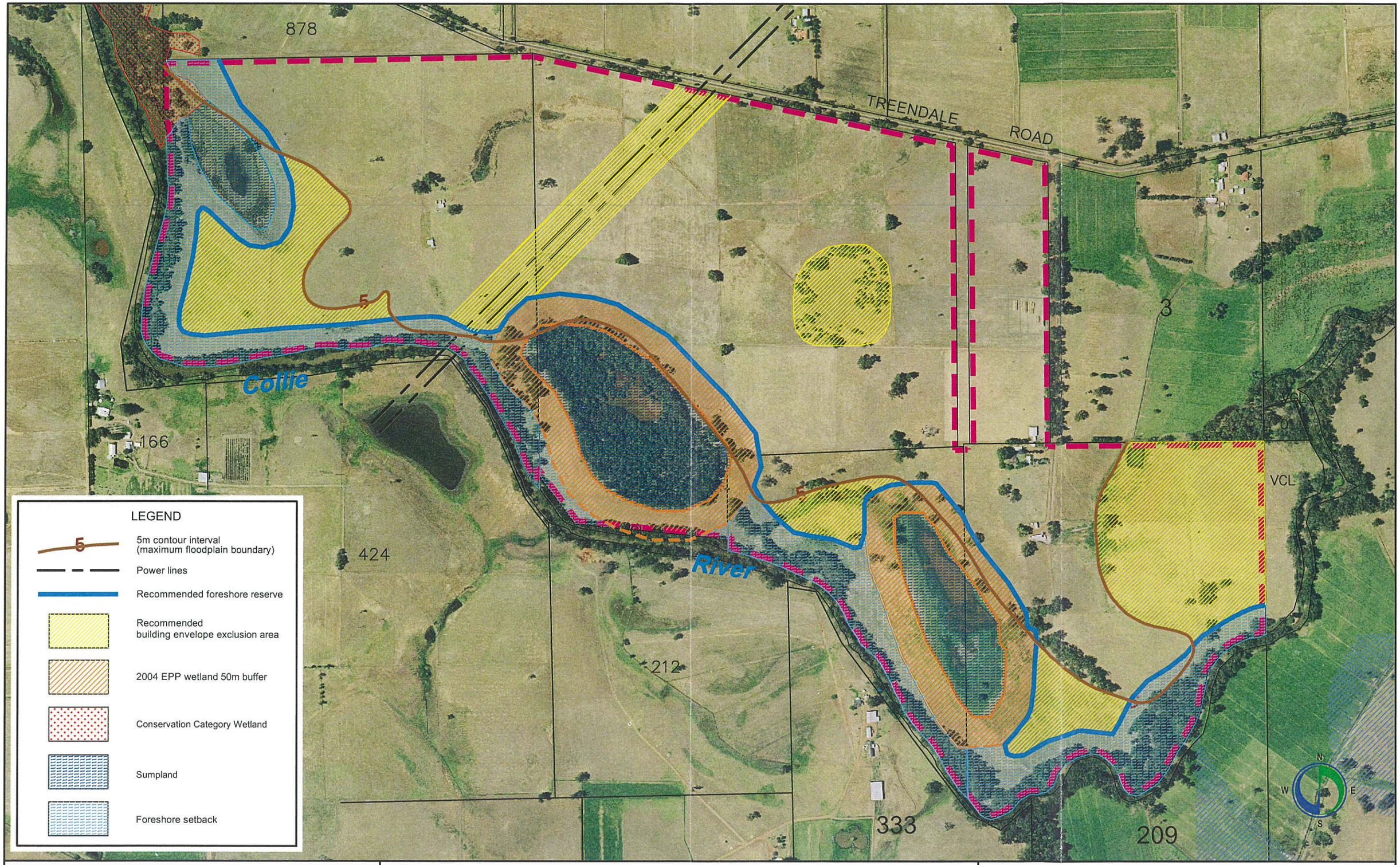

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT
Roelands Environmental Assessment

DRAWING TITLE
Figure 7: Recommended Foreshore Reserves & Building Envelope Exclusion Areas

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Project Number V6003	Drawing Number SK07	Revision	

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Appendix A

DRF and Priority Flora Database Search

Total No. of Records = 16

Species Name	Cons.	Pop ID	No. Plants	Latitude	Longitude	Purpose	Vest
Anthotium junciforme	4	9		33^20'35.7"	115^46'15.4"	Road Verge	SHI
Aponogeton hexatepalus	4	16A	430	33^19'54.7"	115^45'17.4"	Railway Reserve	RAI
	4	16B	420	33^19'54.7"	115^45'17.4"	Railway Reserve	RAI
	4	16C	570	33^19'52.7"	115^45'23.4"	Railway Reserve	RAI
	4	16D	370	33^19'50.7"	115^45'26.4"	Railway Reserve	RAI
	4	16E	123	33^19'48.7"	115^45'31.4"	Railway Reserve	RAI
	4	16F	822	33^19'47.7"	115^45'33.4"	Other	MWO
	4	16G	1500	33^19'42.7"	115^45'47.4"	Other	NON
	4	16H	220	33^19'43.7"	115^45'50.4"	Other	NON
	4	16I	16	33^19'45.7"	115^45'43.4"	Railway Reserve	RAI
	4	16J		33^19'51.7"	115^45'27.4"	Railway Reserve	RAI
	4	23	10	33^19'35.7"	115^47'00.4"	Railway Reserve	RAI
Caladenia speciosa	4	8		33^17'55.7"	115^44'05.4"		UNK
Drosera marchantii subsp. marchantii	C	2	30	33^20'07.7"	115^45'23.4"	Railway Reserve	RAI
Rhodanthe pyrethrum	3	2		33^20'07.7"	115^45'23.4"	Railway Reserve	RAI
	3	4A		33^19'10.7"	115^44'11.4"	Road Verge	SHI

Appendix B

Priority Fauna Database Search

33.2462 °S 115.722 °E / 33.3539 °S 115.83 °E Roelands (plus 5km buffer)

*	Date	Certainty	Seen	Location Name	Method

Schedule 1 - Fauna that is rare or is likely to become extinct

Pseudocheirus occidentalis **Western Ringtail Possum** *1 records*

This species occurs in areas of forest and dense woodlands and requires tree hollows and/or dense canopy for refuge and nesting.

2005	1	1	Burekup	Dead

Schedule 4 - Other specially protected fauna

Falco peregrinus **Peregrine Falcon** *1 records*

This species is uncommon and prefers areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land.

1975	1	1	Brunswick	Day sighting

* Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

Appendix C

Threatened Ecological Community Database Search

17. SCP3c Eucalyptus calophylla - Xanthorrhoea preissii woodlands and shrublands, Swan Coastal Plain

Has the community been endorsed by the Minister for Yes
Current Category: Critically Endangered

Occ.	Buffer		Datum	Longitude	Latitude
22.	500	Site ID	Datum	Longitude	Latitude
		WATER05	GDA94	115° 46' 5"	-33° 19' 32"
25.	500	Site ID	Datum	Longitude	Latitude
		WATER03	GDA94	115° 45' 38"	-33° 19' 47"

33. SCP08 Herb rich shrublands in clay pans

Has the community been endorsed by the Minister for Yes
Current Category: Vulnerable

Occ.	Buffer		Datum	Longitude	Latitude
9.	1000	Site ID	Datum	Longitude	Latitude
		WATER04	GDA94	115° 45' 44"	-33° 19' 44"

Appendix D

Soil Profile Log Sheets

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL1		Time	0830
GPS Location			Drill Method	Excavator			
E 386706	N 6314917						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sand	Pale grey	dry	even	Fine grain	
		Clay	Yellow	moist	highly plastic		
1m							
		Clay	Mottled Red/grey	moist	even	Very heavy	
2m							
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL2		Time	0905
GPS Location			Drill Method	Excavator			
E 386580	N 6314848						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sandy clay	Pale grey	dry	even	clumping	
		Clay	Yellow	moist			
			gravelly				
1m							
		Clay	Mottled	moist	Uneven	gritty	
			Red/grey				
2m		Clay	yellow		even	heavy	
					solid		
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL3		Time	0930
GPS Location			Drill Method	Excavator			
E 386329	N 6314901						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven	Fine grain	
		Sandy Quartz	Pale grey	dry	even		
1m		Clay	Yellow	moist	uneven	Medium/coarse	
			gravelly				
2m							
		Clay	yellow		even	heavy	
					solid		
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL4		Time	1000
GPS Location			Drill Method	Excavator			
E 386455	N 6314754						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Loamy sand	dry	uneven	Fine grain	
		Clay	Brown	dry	uneven	Coarse grain	
		Clay	White/grey	dry	uneven	Very hard	
						packed	
1m							
		rock	cemented	dry		Very hard	
			Laterite &			packed	
			clay				
2m	End of	hole					
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL5		Time	1035
GPS Location			Drill Method	Excavator			
E 386029	N 6314881						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sandy clay	Pale grey	dry	even	Quartz, fine grain	
1m		Clay	Mottled	moist	Uneven	gritty	
			Red/grey				
2m		Clay	yellow	moist	even	highly	
					solid	plastic	
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL6		Time	1110
GPS Location			Drill Method	Excavator			
E 385856	N 6314832						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Loamy sand	dry	uneven	Fine grain	
		Sandy clay	Pale grey	dry	even	fine grain	
		Clay	Yellow/	dry	uneven	slightly	slightly
			orange			cemented	mottled
1m							
		Clay	Mottled	moist	Uneven	gritty	Highly
2m			Red/grey				plastic
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL7		Time	1125
GPS Location			Drill Method	Excavator			
E 385641	N 6314736						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Loamy earth	dry	uneven	Fine grain	
		Earthy	red	dry	small even	slightly	
		Clayey				plastic	
		sand					
1m							
2m							
		Clay	Mottled	moist	Uneven	gritty	
3m			Red/grey				
End of	hole						
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL8		Time	1145
GPS Location			Drill Method	Excavator			
E 385596	N 6314907						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	hard loamy earth	dry	uneven	Fine grain	
		Earthy	red	dry	small even	slightly	
		Clayey				plastic	
		Clay	Red/orange	moist	Uneven	Highly	Hard
1m						plastic	packed
2m							
		Clay	mottled	moist	uneven	gritty	Highly
3m			red/grey				plastic
End of	hole						
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL9		Time	1205
GPS Location			Drill Method	Excavator			
E 386549	N 6315024						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Sandy earth	dry	uneven		
		Clayey sand	Pale grey	dry	even	fine grain	
		Clay	Bright	moist	even	highly	
		gravelly	yellow		solid	plastic	
1m							
		Clay	Mottled	moist	Uneven	gritty	Highly
			Red/grey				plastic
2m							
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL10		Time	1235
GPS Location			Drill Method	Excavator			
E 386426	N 6314717						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven	Fine grain	
		Loamy	brown	dry	uneven	grainy	
		earth					
1m							
		Clay	orange	moist	uneven	Fine grained	Highly
			gravelly				plastic
2m							
3m		Clay	Mottled	wet	even	Highly plastic	
			Grey/yellow				
End of	hole						
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL11		Time	1310
GPS Location			Drill Method	Excavator			
E 386098	N 6314724						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sandy clay	Light brown	dry	uneven	+fines	
		Clay	Yellow	dry	even	clumping	medium
							grained
1m							
		Clay	Mottled	dry	Uneven	gritty	
			Red/grey				
2m		Clay	Pale grey	dry		Highly	
						plastic	
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL12		Time	1330
GPS Location			Drill Method	Excavator			
E 386697	N 6314595						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sandy	Yellow	dry	even	clumping	medium
		Clay					grained
1m							
		Clay	Mottled	dry	Uneven	Highly	
2m			brown/grey			plastic	
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL13		Time	1400
GPS Location			Drill Method	Excavator			
E 387061	N 6314364						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Earthy	red	dry	even	slightly	
		Clayey			Fine	plastic	
		sand			grained		
1m							
		Gravely	Yellow/	dry	Coarse	quartz	
		Clay	orange		grained		
2m							
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL14		Time	1430
GPS Location			Drill Method	Excavator			
E 386809	N 6314105						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Clayey earth	dry	uneven		
		Clay/	red	Dry	even		
		Sandy					
		clay					
1m							
		clay	Solid white/	dry	uneven	Hard	cemented
			grey			packed	
2m	End of	hole					
3m							
4m							

Appendix E

Soil Sample Analysis Results

00067051
Cardno BSD
PO Box 155
SUBIACO
6904

CSBP ANALYSIS REPORT

RECEIVED
BSD CONSULTANTS
16 FEB 2006
ACTION
FILE

Date - . . . 13/0
Time - . . . 14:1

Job: DQS06
O/N:
Date Received: 07/02/06
NON ROUTINE

COREMANS DAVID V6003

Sample number:	RL1	RL2	RL3	RL4	RL7	RL8	Scheme	Units
Serial Number:	RL1	RL2	RL3	RL4	RL7	RL8		
Lab number:	DQS06104	DQS06105	DQS06106	DQS06107	DQS06108	DQS06109		
Texture							SRC001	
Gravel							SRC001	%
Colour							SRC001	
Nitrate Nitrogen							SNN001	mg/Kg
Ammonium Nitrogen							SNN001	mg/Kg
Phosphorus Colwell	41	16	8	21	11	77	SPK001	mg/Kg
Potassium Colwell	49	55	35	85	131	93	SPK001	mg/Kg
Sulphur							SSU001	mg/Kg
Organic Carbon							SOC001	%
Reactive Iron							SFE001	mg/Kg
Conductivity							SPH001	dS/m
pH Level (CaCl2)							SPH001	pH
pH Level (H2O)							SPH001	pH
Total Phosphorus	110	67	66	101	145	458	STP001	mg/Kg
Phosphorus Retention	1.8	59.7	6.5	76.2	115.1	159.6	SPR001	
EMP Exchangeable	.00	.00	.00	.00	.00	.00	SMG001	

00067051
Cardno BSD
PO Box 155
SUBIACO
6904

CSBP

A N A L Y S I S R E P O R T

RECEIVED
BSD CONSULTANTS
16 FEB 2006
RL14
RL14
ACTION
FILE
DQS06114
V6003

Date - . . . 13/0
Time - . . . 14:1

Job: DQS06
O/N:
Date Received: 07/02/06
NON ROUTINE

COREMANS DAVID V6003

Sample number:	RL9	RL10	RL11	RL13		Scheme	Units
Serial Number:	RL9	RL10	RL11	RL13			
Lab number:	DQS06110	DQS06111	DQS06112	DQS06113			
Texture						SRC001	
Gravel						SRC001	%
Colour						SRC001	
Nitrate Nitrogen						SNN001	mg/Kg
Ammonium Nitrogen						SNN001	mg/Kg
Phosphorus Colwell	71	14	27	103	174	SPK001	mg/Kg
Potassium Colwell	289	54	83	338	374	SPK001	mg/Kg
Sulphur						SSU001	mg/Kg
Organic Carbon						SOC001	%
Reactive Iron						SFE001	mg/Kg
Conductivity						SPH001	dS/m
pH Level (CaCl2)						SPH001	pH
pH Level (H2O)						SPH001	pH
Total Phosphorus	442	315	132	435	562	STP001	mg/Kg
Phosphorus Retention	36.0	1,427.7	55.8	71.2	80.7	SPR001	
EMP Exchangeable	.00	.00	.00	.00	.00	SMG001	

PLATES

Plate 1 Test Pit RL1

Plate 2 Test Pit RL2

Plate 3 Test Pit RL3

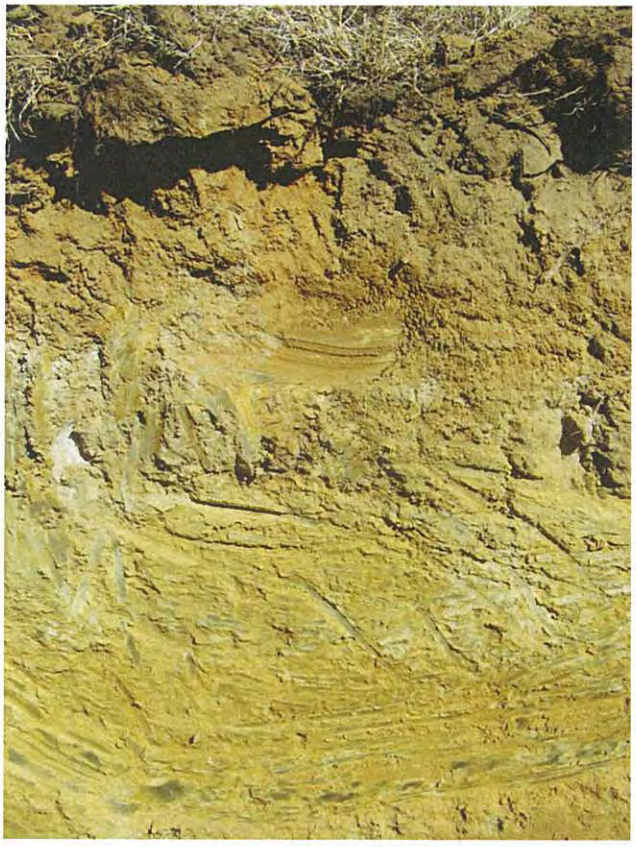

Plate 4 Test Pit RL4

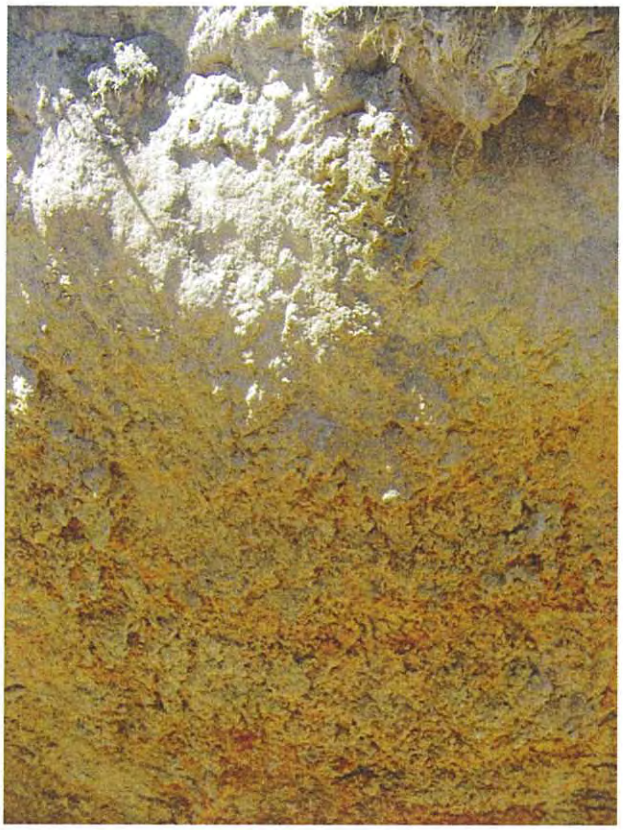

Plate 5 Test Pit RL5

Plate 6 Test Pit RL6

Plate 7 Test Pit RL7

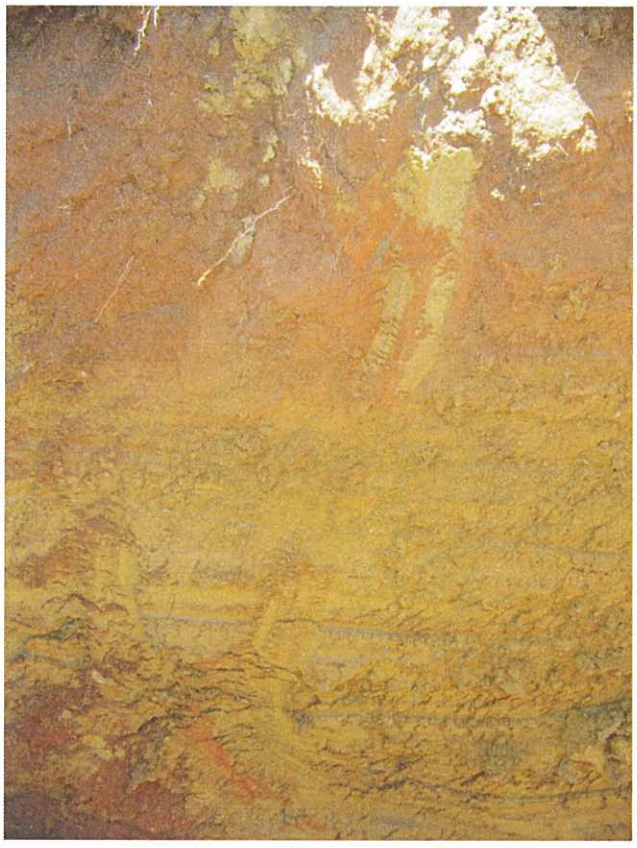

Plate 8 Test Pit RL8

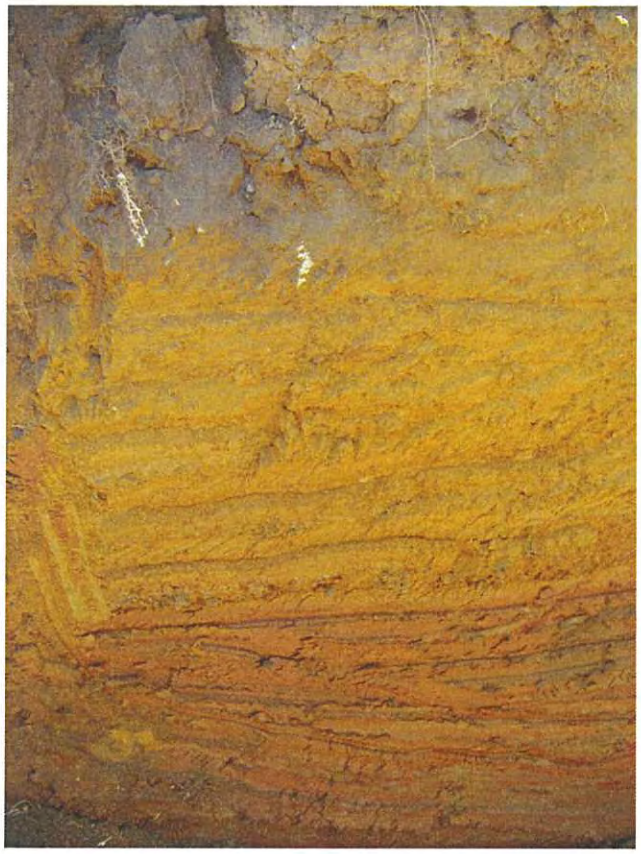

Plate 9 Test Pit RL9

Plate 10 Test Pit RL10

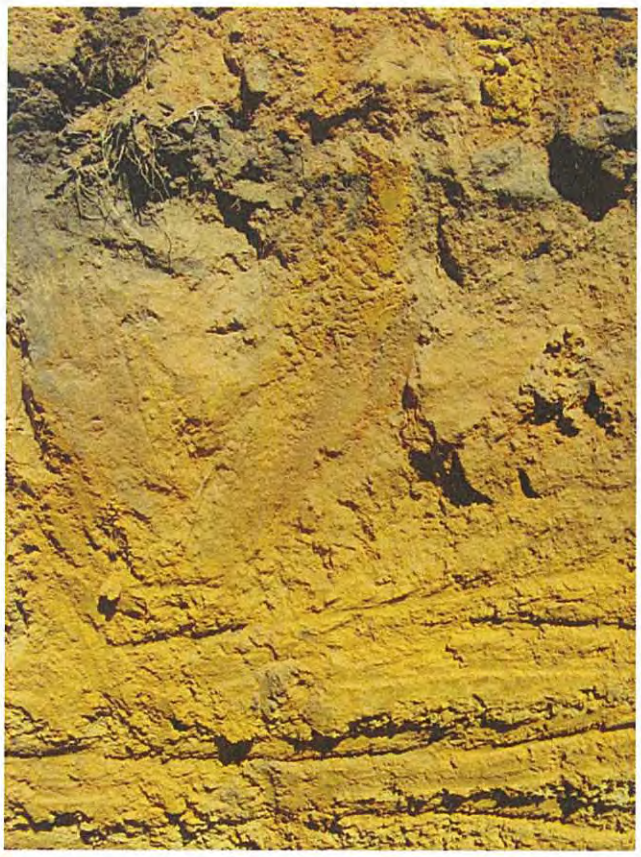

Plate 11 Test Pit RL11

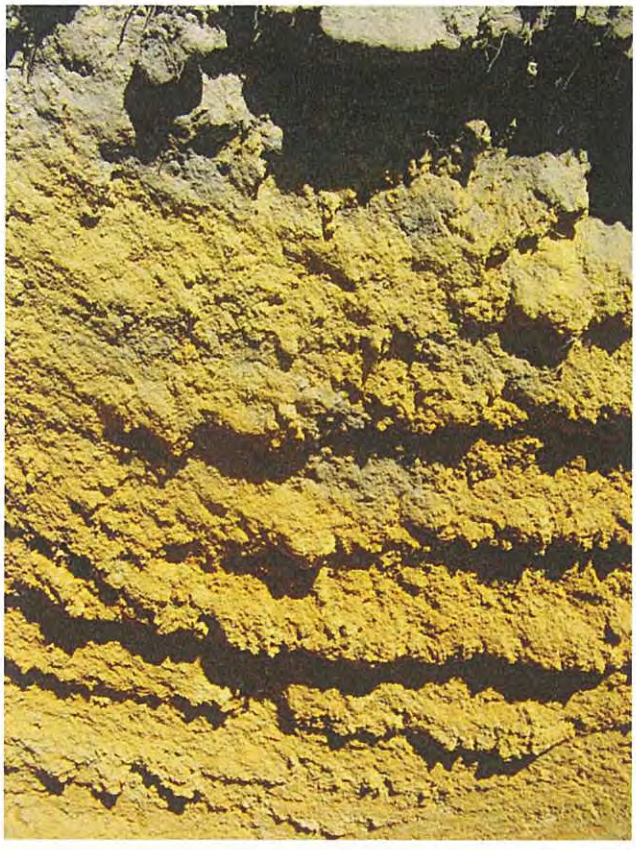

Plate 12 Test Pit RL12

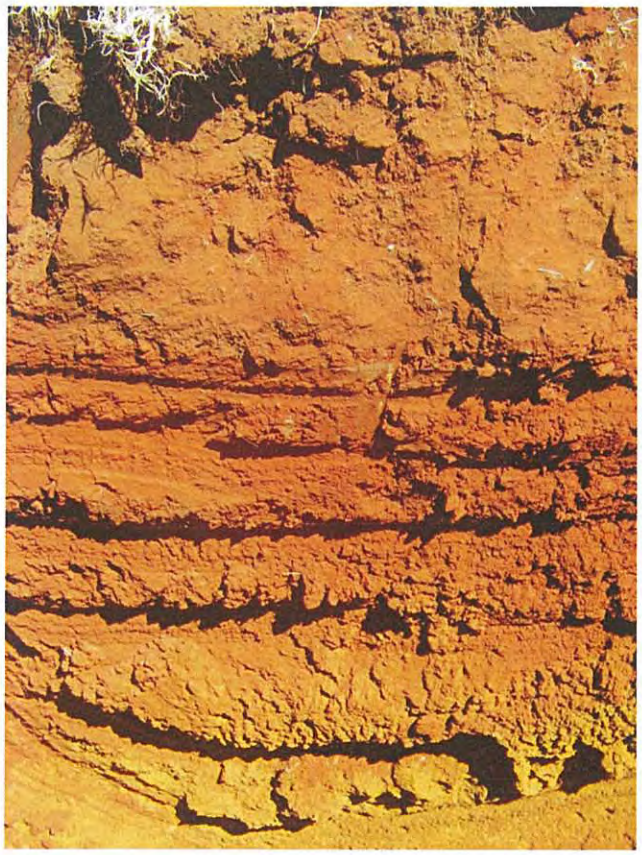

Plate 13 Test Pit RL13

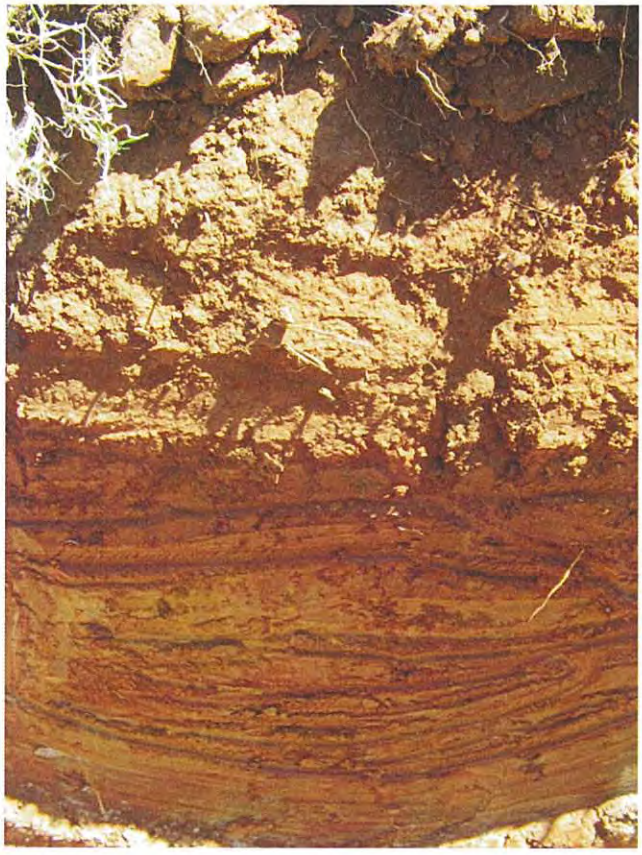

Plate 14 Test Pit RL14

Plate 15 Condition of vegetation in northern portion of study area – eastern end

Plate 16 Condition of vegetation in north portion of study area – western end

Plate 17 Condition of vegetation along Collie River (pt 1)

Plate 18 Condition of vegetation along Collie River (pt2)

Plate 19 Condition of 'sumpland' area within wetland #1736

Plate 20 Condition of wetland #1869

Plate 21 Condition of wetland #1718

Appendix B

Geotechnical Investigation (Golder and Associates, 2017)

14 August 2017 Document No. 1772403-006-L-Rev0

Andrew McIntyre

e-mail: andrew.mcintyre@outlook.com.au

GEOTECHNICAL REPORT ON 260 TREENDALE ROAD, ROELANDS

Dear Andrew,

1.0 INTRODUCTION

This letter presents the results of a preliminary geotechnical investigation undertaken by Golder Associates Pty Ltd (Golder) for 260 Treendale Road, Roelands.

We understand the site is being considered for future land development opportunities. The site locations are shown on Figure 1, Location Plan.

The overall aim of the work was to provide a preliminary assessment of the geotechnical suitability of the site for future land development. The objectives of the study were to assess the subsurface soil and groundwater conditions across the site.

2.0 FIELDWORK

The fieldwork was conducted on 13 January 2017 and comprised:

- Excavation of test pits at eighteen locations, T-TP1 to T-TP18, extending to depths of between 1.3 m and 2.5 m.
- Testing with a dynamic cone penetrometer (DCP) adjacent to each test pit, extending to depths of up to 1.05 m.

The test locations were recorded using a hand held GPS accurate to about 5 m. Test pit locations for the site are shown on Figure 2.

Test pits were excavated using a mini-excavator supplied and operated by DRS Contracting. The test pit reports are presented in Attachment A, along with a list of notes and abbreviations and a description of the soil classification system used on the reports.

PSP and DCP testing was undertaken in accordance with test method AS 1289.6.3.3 and AS 1289.6.3.2, except that the depth of testing was greater than covered by the standard for PSP testing and the blow counts was recorded at 150 mm intervals for the DCP testing. The results are provided on the relevant test pit reports.

A geotechnical engineer from Golder located the tests, logged the materials encountered in the test pits, collected soil samples and conducted the penetrometer testing.

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3.0 SITE CONDITIONS

3.1 Regional Geology

The Bunbury-Burekup sheet of the 1:50,000 Environmental Geology Series maps indicate that the site is likely to be underlain by Guildford Formation "*mainly alluvial sandy clay*".

3.2 Topography and Site Features

The site is relatively flat (based on available 1 m contours) with a slope from east to west across the site. The eastern edge of the lots is at approximately RL 17 m AHD falling to approximately RL 14 m AHD at the western edge of the lots. The total area of the site is approximately 260 ha and is generally bounded by Treendale Road to the south and farmland to the north, east and west. Raymond Road crosses the site in an east-west direction.

The site is predominantly cleared of vegetation, with a covering of grass and sparsely spaced mature trees. A number of surface water features can be identified across the site.

The southern edge of the lots is located approximately 0.3 km to 0.5 km from the Collie River. The available topographic information indicates that the Collie River main channel and adjacent floodplain is more than about 10 m lower than the Raymond Road sites.

3.3 Subsurface Profile

Based on the field investigation results, subsurface conditions at the Roelands site at the time of the investigation can be generalised as follows:

- TOPSOIL – Silty SAND (SM): fine to medium grained, black, ~10-15% low plasticity fines, trace organics, loose to medium dense, moist to dry, extending from the ground surface to depths of between about 0.15 m and 0.2 m, overlying
- Clayey SAND (SC): fine to medium grained, yellow, grey, low to medium plasticity, generally medium dense to dense, dry to moist, containing weakly to well cemented (laterised) zones, extending to depths of between 0.4 m and the maximum depth investigated of 2.5 m, overlying

CLAY/Sandy CLAY (CI-CH): medium to high plasticity, fine to medium grained, grey with red and orange mottling, generally stiff to very stiff, containing weakly cemented zones, extending to the maximum depth investigated of 2.5 m.

3.4 Groundwater

Groundwater was encountered at one location, T-TP8, at the Roelands site at a depth of 2.5 m below ground level.

Given the time of the year at which the investigation was performed, groundwater may be more than 1 m higher following winter rainfall. During wet periods water is likely to perch on the clayey soils encountered at the Roelands site, leading to inundation.

4.0 PRELIMINARY ASSESSMENT

Clayey soils were encountered below a thin covering of topsoil during the preliminary field investigation and are generally considered likely to be moderately reactive. Moderately to highly reactive clay may result in reduced bearing capacity for shallow footings, thicker pavement design and increased surface movement due to shrink-swell effects between wet and dry seasons. Sand fill will need to be placed to provide adequate on-site drainage, improve subgrade conditions for pavements and limit the effect of shrink-swell movements.

The clay was generally stiff to hard; however, a zone of soft clay was encountered at one location and the potential for localised soft zones to be present elsewhere cannot be discounted. Surficial clayey soils are likely to soften in winter, particularly where surface water is unable to drain freely.

Groundwater was only encountered at one location during the preliminary field investigation; however, perched groundwater/surface water may occur at the site during winter months due to the presence of clayey soils at the surface.

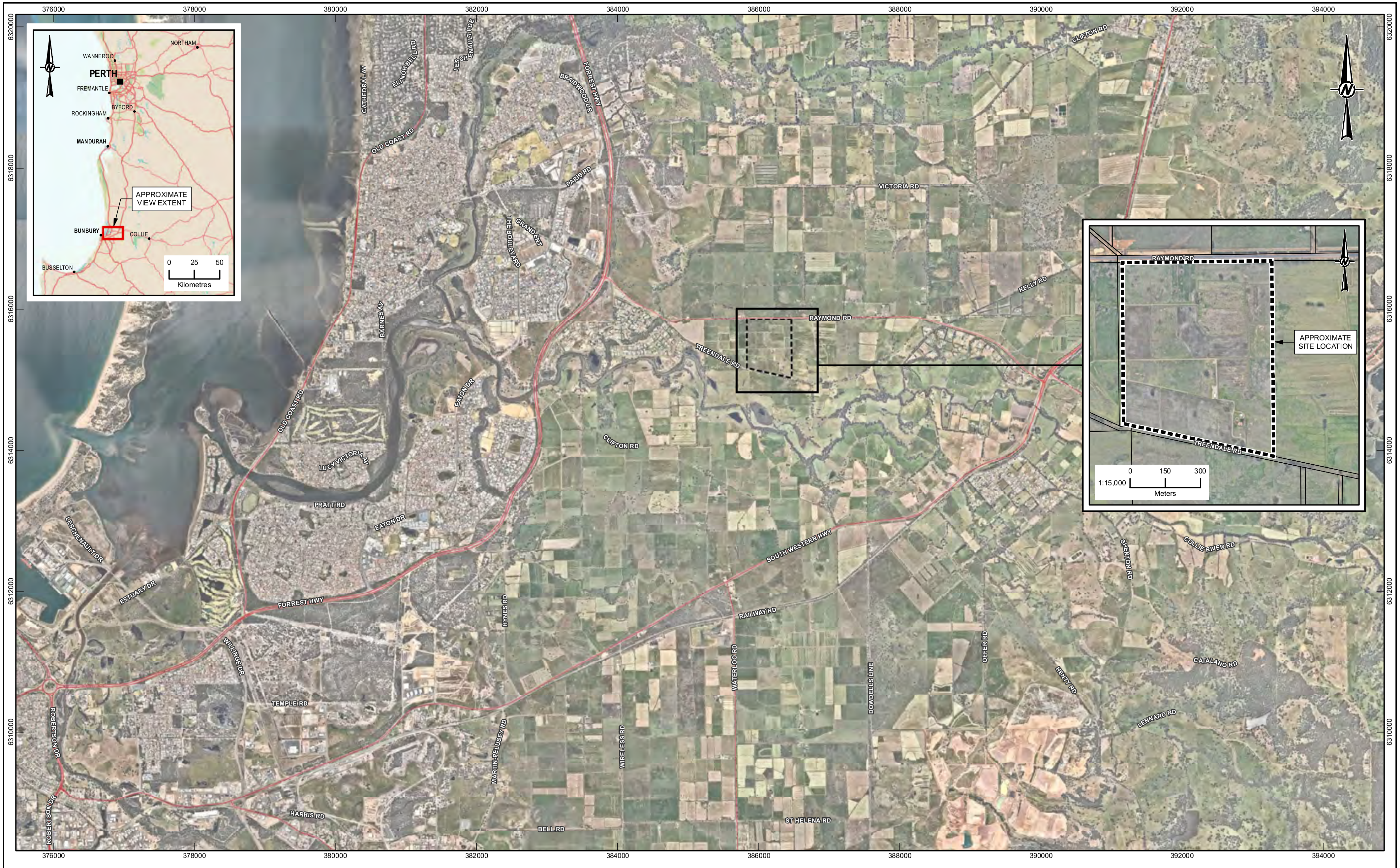
Given the presence of clayey soils from close to the surface, there is expected to be very limited potential to infiltrate surface water via swales or basins at the site.

GOLDER ASSOCIATES PTY LTD

Simon Hope
Senior Geotechnical Engineer

SL/SNH/sl

Attachments: Figure 1 – Location Plan
Figure 2 – Roelands Site Plan
A – Test Pit Reports



REFERENCE

AERIAL IMAGERY SOURCED FROM NEARMAP. DATED NOVEMBER 2016 / MAY 2017..

CADSTRAL BASED ON INFORMATION PROVIDED BY AND WITH THE PERMISSION OF THE WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2017)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

0 1,000 2,000
1:50,000 METRES

CLIENT
MR ANDREW MCINTYRE

PROJECT
260 TREENDALE ROAD, ROELANDS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-08-14
DESIGNED	SNH
PREPARED	JRP
REVIEWED	SNH
APPROVED	SNH

TITLE
LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1772403	006 L	0	1

25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

Path: B:\99_PROJECTS\1772403_SN02_PRODUCTION\MXD\006-L\Rev0\1772403-006-L-F001-Rev0.mxd

LEGEND

TEST PIT LOCATION

REFERENCE

CADSTRAL BASED ON INFORMATION PROVIDED BY AND WITH THE PERMISSION OF THE WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2017).

AERIAL IMAGERY SOURCED FROM NEARMAP. DATED MAY 2017.

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

0 100 200
1:4,000 METRES

CLIENT
MR ANDREW MCINTYRE

PROJECT
260 TREENDALE ROAD, ROELANDS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-08-14
DESIGNED	SNH
PREPARED	JRP
REVIEWED	SNH
APPROVED	SNH

TITLE
ROELANDS SITE PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1772403	006 L	0	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

0

ATTACHMENT A
Test Pit Reports

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT REPORTS

DRILLING/EXCAVATION METHOD

AS*	Auger Screwing	RD	Rotary blade or drag bit	HQ	Diamond Core - 63 mm
AD*	Auger Drilling	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
*V	V-Bit	RAB	Rotary Air Blast	NQ	Diamond Core - 47 mm
*T	TC-Bit, e.g. ADT	RC	Reverse Circulation	BH	Tractor Mounted Backhoe
HA	Hand Auger	PT	Push Tube	EX	Tracked Hydraulic Excavator
ADH	Hollow Auger	CT	Cable Tool Rig	EE	Existing Excavation
DTC	Diatube Coring	JET	Jetting	HAND	Excavated by Hand Methods
WB	Washbore or Bailer	NDD	Non-destructive drilling		

PENETRATION/EXCAVATION RESISTANCE

L **Low resistance.** Rapid penetration possible with little effort from the equipment used.

M **Medium resistance.** Excavation/possible at an acceptable rate with moderate effort from the equipment used.

H **High resistance** to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.

R **Refusal or Practical Refusal.** No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.

These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.

WATER

▽	Water level at date shown	◁	Partial water loss
▷	Water inflow	◀	Complete water loss

GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (s_v = peak value, s_r = residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure tests

Ranking of Visually Observable Contamination and Odour (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible contamination	R = B	Slight non-natural odours identified
R = 2	Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

$$= \frac{\textit{Length of core recovered}}{\textit{Length of core run}} \times 100$$

SCR = Solid Core Recovery (%)

$$= \frac{\sum \textit{Length of cylindrical core recovered}}{\textit{Length of core run}} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum \textit{Axial lengths of core} > 100\ \textit{mm}}{\textit{Length of core run}} \times 100$$

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT REPORTS

 FILL

 GRAVEL (GP or GW)

 SAND (SP or SW)

 SILT (ML or MH)

 CLAY (CL, CI or CH)

 ORGANIC SOILS (OL or OH or Pt)

 COBBLES or BOULDERS

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

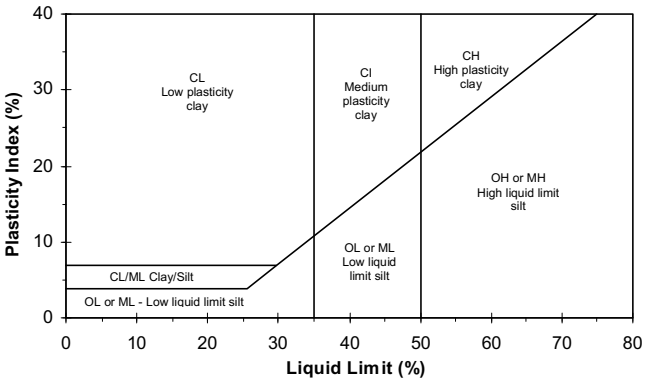
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. The material properties are assessed in the field by visual/tactile methods.

Particle Size

Major Division	Sub Division	Particle Size
BOULDERS		> 200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	20 to 63 mm
	Medium	6.0 to 20 mm
	Fine	2.0 to 6.0 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties



MOISTURE CONDITION

AS1726 - 1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays & Silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition & may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726 - 1993

Symbol	Term	Undrained Shear Strength
VS	Very Soft	0 to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa
H	Hard	Above 200 kPa

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	Less than 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Dense	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

SPT correlations are not stated in AS1726 – 1993, and may be subject to corrections for overburden pressure and equipment type.

REPORT OF TEST PIT: T-TP01

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 385894 m E 6315809 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					SM	Silty SAND fine to medium grained, black, ~10-15 % low plasticity silt, trace organics	M	L	~75mm of topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~30-40 % medium plasticity clay	D - M	MD - D		
			0.5										
			1.0							M			
			1.5	1.50	1.50 m Pocket Penotrometer = 1.8, 2.0 , 2.2 kg/cm2			CH	Sandy CLAY / CLAY fine to medium grained, quartz sand, low to medium plasticity, brown with orange, trace fine grained quartz gravel	M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP02

CLIENT:	Mr Andrew McIntyre	COORDS: 386023 m E 6315786 m N MGA94 50	SHEET: 1 OF 1
PROJECT:	260 Treendale Road, Roelands	SURFACE RL: DATUM: AHD	MACHINE: JCB 8035 ZTS
LOCATION:	260 Treendale Road, Roelands		CONTRACTOR: DRS Contracting
JOB NO:	1772403	PIT DEPTH: 2.00 m	LOGGED: DMS DATE: 13/1/17
		BUCKET TYPE: 600m toothed	CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0		BLK 0.70-0.90 m Rec = 200/200 mm Pocket Penotrometer = 3.5, 4.2, 3.8 kg/cm2			SM	Silty SAND fine to medium grained, black, ~10-15 % low plasticity fines silt, trace organics	M	L	adjacent to low lying natural 'swale' - greener area with higher moisture content ~75 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, dark yellow, ~30-40 % medium platicity clay				
			0.5										
			1.0							M	MD		
			1.5										
				1.70				CI / CH	Sandy CLAY / CLAY fine to medium grained, quartz sand, low to medium plasticity, brown with red orange mottling, trace quartz gravel		VSt - H		
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP03

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386151 m E 6315794 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.10 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					SM	Silty SAND fine to medium grained, black, ~10-15 % low plasticity silt, trace organics	D - M	L	~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow with red, ~25-30 % medium plasticity clay		D		
			0.5	0.50	0.50 m Pocket Penotromer = 2.5, 3.0, 3.0 kg/cm2			CH	CLAY high plasticity, with some quartz sand, trace fine to medium grained quartz gravel	M	VSt		
			1.0										
			1.5										
				1.80				SC	Clayey SAND fine to coarse grained, angular, quartz sand, grey, ~30-40 % medium plasticity clay, trace fine grained quartz gravel		MD		
			2.0						TEST PIT DISCONTINUED @ 2.10 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP04

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386265 m E 6315795 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~15 % low plasticity silt, trace organics	D	MD	Adjacent Mature Trees - possibly more sand cover ~50 mm topsoil	0 5 10 15 20 25
				0.20					pale grey, ~10% fines				
				0.40				SC	Clayey SAND fine to medium grained, yellow with orange, ~25-30 % medium plasticity clay, with weakly cemented / laterized zones		D		
			0.5										
			1.0							M			
				1.30				CL	Sandy CLAY fine to medium grained, quartz sand, brown with grey, trace fine grained quartz gravel				
	L-M		1.5							M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP05

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386071 m E 6315735 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt	D		~50 mm topsoil	0 5 10 15 20 25
				0.20					grey, with some clay				
				0.40				CI	Sandy CLAY fine to medium grained, quartz sand, low plasticity, grey with orange		VSt		
			0.5										
			1.0	1.00	1.00 m Pocket Penotrometer = 2.3, 2.4, 2.6 kg/cm2			SC-SM / CL	Clayey Silty SAND / Sandy Silty CLAY fine grained sand, low plasticity, pale yellow, weakly cemented in parts, trace fine grained gravel	M			
	M-H		1.5								D - VSt		
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP06

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 385885 m E 6315625 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.20 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					ML	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt, trace organics	M		~50 mm topsoil	0 5 10 15 20 25
				0.15				SC	Clayey SAND fine to medium grained, quartz sand, dark yellow, ~30-40 % medium plasticity clay, weakly laterised in parts	D - M	L - MD		
			0.5										
			1.0							M	MD		
			1.5										
				1.70	1.70 m Pocket Penotrometer = 1.6, 1.8, 2.0 kg/cm2			CI-CH	Sandy CLAY / CLAY fine to coarse grained, quartz sand, medium to high plasticity, grey with red and orange, trace fine grained gravel	M	St - VSt		
			2.0										
									TEST PIT DISCONTINUED @ 2.20 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP07

CLIENT:	Mr Andrew McIntyre	COORDS: 386020 m E 6315610 m N MGA94 50	SHEET: 1 OF 1
PROJECT:	260 Treendale Road, Roelands	SURFACE RL: DATUM: AHD	MACHINE: JCB 8035 ZTS
LOCATION:	260 Treendale Road, Roelands	PIT DEPTH: 2.20 m	CONTRACTOR: DRS Contracting
JOB NO:	1772403	BUCKET TYPE: 600m toothed	LOGGED: DMS DATE: 13/1/17
			CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt, trace organics	M	L	~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow with red, ~30-40 % medium plasticity, laterized in parts clay, trace gravel	D - M	MD - D		
			0.5										
			1.0										
			1.5							M			
				1.90				CI-CH	Sandy CLAY fine to coarse grained, quartz sand, medium to high plasticity, grey with red and orange, friable, trace fine grained quartz gravel	M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.20 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP08

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386142 m E 6315621 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.50 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0		DS 0.00-0.20 m Rec = 300/200 mm			SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt, trace organics			Adjacent to open drain ~75 mm topsoil	0 5 10 15 20 25
				0.15				SP	SAND fine to medium grained, quartz sand, grey, trace silt				
			0.5										
				0.65					CEMENTED SAND fine to medium grained, brown, in a cemented matrix, weakly - well cemented, excavated as a sand and fine to coarse grained gravel				
				0.80				SC	Clayey SAND fine to medium grained, quartz sand, orange with grey, ~30-40 % medium plasticity fines, weakly cemented in parts clay, trace fine grained quartz gravel	M	MD		
			1.0										
			1.5										
			2.0							M - W			
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.50 m DEPTH BACKFILLED	W		slow seepage through base	
			3.0										

This report of test pit must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

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REPORT OF TEST PIT: T-TP09

CLIENT:	Mr Andrew McIntyre	COORDS: 386271 m E 6315620 m N MGA94 50	SHEET: 1 OF 1
PROJECT:	260 Treendale Road, Roelands	SURFACE RL: DATUM: AHD	MACHINE: JCB 8035 ZTS
LOCATION:	260 Treendale Road, Roelands	PIT DEPTH: 2.10 m	CONTRACTOR: DRS Contracting
JOB NO:	1772403	BUCKET TYPE: 600m toothed	LOGGED: DMS DATE: 13/1/17
			CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0					SM	SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines , trace organics	M	L	Reeds in paddock from irrigation, low in terms of relative topography Very low infiltration rate, undulating surface from cow hoof imprints	
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~30-35 % medium plasticity clay				
			0.5		DS 0.50-1.00 m Rec = 500/500 mm 1 bag					D	D		20+ refusal
			1.0							M	MD		
			1.5	1.50				CI / CH	Sandy CLAY / CLAY fine to medium grained, quartz sand, medium to high plasticity, grey with red	M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.10 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

This report of test pit must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

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REPORT OF TEST PIT: T-TP10

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 385884 m E 6315464 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.10 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0	0.10				SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt, trace organics			~75 mm topsoil	0 5 10 15 20 25
								SC	Clayey SAND fine to medium grained, quartz sand, pale yellow, ~15-25 % low plasticity clay				
			0.5	0.30	BDS 0.30-0.70 m Rec = 400/400 mm 2 bags			SC	Clayey SAND fine to medium grained, quartz sand, ~25-40 % medium plasticity clay, with some gravel	M	MD		
			1.0										
			1.5	1.50	1.50 m Pocket Penotrometer = 3.0, 3.0m 3.6 kg/cm2 BLK 1.70-2.00 m Rec = 300/300 mm			CI / CH	CLAY / Sandy CLAY fine to medium grained, quartz sand, medium to high plasticity, grey with red, trace fine grained quartz gravel	M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.10 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP11

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386016 m E 6315469 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.20 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines silt, trace organics	D - M	MD	~100 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~30-40 % medium plasticity fines clay		MD - D		
			0.5										
			1.0										
			1.5										
				1.60				CI	Sandy CLAY fine to medium grained, quartz sand, low plasticity, grey with red and orange, trace fine grained quartz gravel, weakly laterised	M	St - VSt		
			2.0		1.80 m Pocket Penotrometer = 1.8 kg/cm2								
									TEST PIT DISCONTINUED @ 2.20 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP12

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386143 m E 6315464 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.50 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines silt, trace organics	M	MD	~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, ~20-25 % low plasticity fines clay, quartz sand, pale brown/yellow				
			0.5	0.50				SC	Clayey SAND quartz sand, orange brown with grey, ~35-50% medium plasticity fines friable clay, trace fine grained quartz gravel		MD - VSt		
			1.0										
			1.5										
				2.00					weakly laterised in parts	M - W			
	M		2.0										
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										

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GAP gINT FN. F01i RL3

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REPORT OF TEST PIT: T-TP13

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386263 m E 6315472 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.30 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines silt, trace organics	M	L	Laser levelled paddock ~400mm lower than other paddock to the south moisture content of soil much higher in paddock ~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow with orange, ~25 % low plasticity fines clay, with some fine grained quartz and lateritised gravel	D	MD		
			0.5		BDS 0.50-1.00 m Rec = 500/500 mm								
			1.0	1.10					close to Clayey Gravelly SAND (SC), medium plasticity	M			
	L-M		1.5	1.70	1.70 m Pocket Penotrometer = 1.6, 1.7, 1.7 kg/cm2			CI / CH	Sandy CLAY / CLAY grey with red mottling, fine to coarse grained quartz sand, medium to high plasticity, trace fine grained quartz gravel	M	St - VSt		
			2.0		DS 2.00-2.20 m Rec = 200/200 mm								
			2.5						TEST PIT DISCONTINUED @ 2.30 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										

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GAP gINT FN. F01i RL3

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REPORT OF TEST PIT: T-TP14

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386359 m E 6315456 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.10 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines silt, trace organics	M	L	Adjacent open draining channel ~100 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~25 % low plasticity fines clay	D	D		
			0.5										
			1.0										
				1.20				SC	Clayey SAND fine to coarse grained, quartz sand, orange with grey, ~30 % medium plasticity fines clay, trace fine to grained quartz gravel	M	MD		
	L-M		1.5										
				1.70	1.80 m Pocket Penotrometer = 2.6 kg/cm2			CI / CH	Sandy CLAY / CLAY fine to medium grained, quartz sand, medium to high plasticity, grey with brown and red, trace fine to grained quartz gravel	M	St - VSt		
			2.0						TEST PIT DISCONTINUED @ 2.10 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP15

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 385906 m E 631519 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, with some silty fines, trace organics			<50 mm root zone	0 5 10 15 20 25
				0.20				SC / SM	Clayey SAND fine to medium grained, grey, ~20-30 % low plasticity fines clay	D - M	L		
			0.5	0.50				SC	Clayey SAND fine to medium grained, grey, ~25-40 % medium plasticity clay, trace fine grained quartz gravel, laterised in parts	M	MD		
				1.80					clay content increasing, close to Sandy CLAY				
			1.0										
			1.5										
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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GAP gINT FN. F01i RL3

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REPORT OF TEST PIT: T-TP16

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386021 m E 6315325 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 1.30 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	H		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, with some silty fines, trace organics		L	~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND pale yellow, ~40 % medium plasticity clay, trace fine grained gravel, weakly lateritised in parts	D	D		20+ refusal (HB)
			0.5		DS 0.30-0.70 m Rec = 400/400 mm								
			1.0										
									TEST PIT DISCONTINUED @ 1.30 m REFUSAL GROUNDWATER NOT ENCOUNTERED BACKFILLED Slow Excavation Rate				
			1.5										
			2.0										
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP17

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386139 m E 6315318 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M-H		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, with some silty fines, trace organics	D	MD	~75 mm roots moisture content is lower in southern portion of farm	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, trace fine grained gravel, weakly laterised in parts	D - M	D		
			0.5										
			1.0										
				1.30				CI	Sandy CLAY fine to medium grained, quartz sand, grey with red and orange, trace fine grained gravel, weakly laterised in parts	M	VSt		
	M		1.5										
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP18

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386273 m E 6315327 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M-H		0.0					SM	Silty SAND fine to medium grained, black, ~15% low plasticity silt, with some silty fines, trace organics	M	L	~70 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~25% medium plasticity clay, trace fine grained gravel, weakly laterised in parts	D	D		
			0.5										
			1.0										
				1.40				SC	Clayey SAND fine to coarse grained, sub-angular, quartz sand, grey with dark yellow, ~30-40 % medium plasticity clay, trace fine grained gravel, weakly laterised in parts	M			
			1.5										
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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Appendix C

Soil Testing Logs (Bio Diverse Solutions, 2021)

Lithological Log

Bore Name:	TP1	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386953E, 6314104N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 20 30 40 50 60	Silty sand	Dark brown	fine	well sorted	dry		
70 80 90 100 110 120 130 140 150 160 170 180 190 200	Sandy clay	dark red/ brown	fine	well sorted	dry	low plasticity	No groundwater encountered
	End of hole						

Lithological Log

Bore Name:	TP2	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386958E, 6314308N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 20 30 40 50 60	Silty sand	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.30m BGL
70 80	Sandy clay	dark red/ brown	fine	well sorted	saturated	low plasticity	
90 100 110 120 130 140 150 160 170 180 190 200	End of hole						

Lithological Log

Bore Name:	TP3	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386814E, 6314503N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 30	Silty sand	Dark brown/grey	fine	well sorted	moist		No groundwater encountered
40 – 90	Sandy clay	orange/ brown	fine	well sorted	saturated	low plasticity	
100 – 200	End of hole						

Lithological Log

Bore Name:	TP4	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386862E, 6314664N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 20 30 40	Silty sand	Dark brown/grey	fine	well sorted	moist		No groundwater encountered
50 60 70 80	Sandy clay	orange/ brown	fine	well sorted	saturated	low plasticity	
90 100 110 120 130 140 150 160 170 180 190 200	End of hole						

Lithological Log

Bore Name:	TP5	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386927E, 6314891N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 20 30	Silty sand	Dark brown	fine	well sorted	dry		No groundwater encountered
40 50 60 70 80 90 100 110 120	Clay	orange/ dark brown	fine sand	well sorted	dry	high plasticity	
130 140 150 160 170 180 190 200	End of hole						

Lithological Log

Bore Name:	TP6	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386989E, 6314629N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 30	Silty sand	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.22m BGL
30 – 90	Sandy clay	brown	fine	well sorted	saturated	medium plasticity	
90 – 200	End of hole						

Lithological Log

Bore Name:	TP7	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386136E, 6314853N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 40	Silty sand	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.34m BGL
40 – 50	Sand	grey	fine	well sorted	saturated		
50 – 100	Sandy clay	light brown	fine sand		saturated	low plasticity	
100 – 150	Gravelly clay	orange/brown	medium gravel		moist	medium plasticity	
150 – 200	End of hole						

Lithological Log

Bore Name:	TP8	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386145E, 6315006N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	Silty sand	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.45m BGL
20							
30							
40							
50							
60							
70	Sandy clay	orange/brown	fine sand	well sorted	saturated	medium plasticity	
80							
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP9	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385911E, 6314826N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	loam	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.44m BGL
20							
30							
40							
50							
60							
70							
80	sandy clay	light grey	fine sand	well sorted	saturated	low plasticity	
90							
100							
110							
120							
130							
140	End of hole						
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP10	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385623E, 6314764N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	loam	Dark brown	fine	well sorted	moist		No groundwater was encountered
20							
30							
40							
50							
60							
70	sandy clay	red brown	fine sand	well sorted	moist	low plasticity	
80							
90							
100							
110							
120							
130							
140							
150	End of hole						
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP11	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386215E, 6315208N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 20	silty sand	Dark grey/brown	fine	well sorted	moist		Groundwater encountered @0.72m BGL
30 – 40 – 50	sand	light grey	fine	well sorted	moist		
60 – 70 – 80 – 90	loamy sand	orange	fine	well sorted	moist-saturated		
100 – 110	clayey sand	orange	fine	well sorted	saturated		
120 – 130 – 140 – 150	sandy clay	orange	fine sand	well sorted	saturated	low plasticity	
160 – 170 – 180 – 190 – 200	End of hole						

Lithological Log

Bore Name:	TP12	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385980E, 6315263N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–50	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.48m
20–60	sand	light grey	fine	well sorted	moist		
60–100	sandy clay	orange/light brown			saturated	low plasticity	
100	End of hole						

Lithological Log

Bore Name:	TP13	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385910E, 6315598N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		
20	sand	light grey	fine	well sorted	moist		
30	sandy clay with gravel	orange/light brown	fine sand, medium gravel	poorly sorted	moist-saturated	low plasticity	Groundwater encountered @ 0.81m
40							
50							
60							
70							
80							
90							
100	End of hole						
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP14	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385666E, 6315332N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.39m
20–40	sand	light grey	fine	well sorted	moist		
40–100	sandy clay	orange/brown	fine sand		saturated	low plasticity	
100–200	End of hole						

Lithological Log

Bore Name:	TP15	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385778E, 6315754N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	Silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.48m
20–120	Sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
120–200	End of hole						

Lithological Log

Bore Name:	TP16	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386193E, 6315791N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		No groundwater encountered
20	sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
30							
40							
50							
60							
70							
80							
90							
100							
110							
120	End of hole						
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP17	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386193E, 6315791N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		No groundwater encountered
20							
30	Sand	light grey	fine	well sorted	moist		
40							
50							
60							
70	Sandy clay	light grey	fine sand	well sorted	moist	low plasticity	
80							
90							
100	End of hole						
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP18	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386462E, 6315142N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.38m
20–130	sandy clay	brown/orange	fine sand		saturated	low to medium plasticity	
130	End of hole						

Lithological Log

Bore Name:	TP19	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386356E, 6315717N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		
20							
30	sandy clay	dark brown	fine sand		saturated	low to medium plasticity	Groundwater encountered @ 0.67m
40							
50							
60							
70							
80	Clay	light orange/brown	fine		moist	medium plasticity	
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP20	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386796E, 6315038N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.37m
20–40	Silty sand	light grey	fine	well sorted	moist to saturated		
40–120	Clayey sand	orange/brown	fine	well sorted	saturated		
120–200							

Lithological Log

Bore Name:	TP21	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386622E, 6315275N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 20	Silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.33m
30 – 40	Sand	light grey	fine	well sorted	moist to saturated		
50 – 70	Silty sand	light brown	fine	well sorted	saturated		
80 – 120	Sandy clay	orange/brown	fine sand		moist	low plasticity	
130 – 200	End of hole						

Lithological Log

Bore Name:	TP22	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386933E, 6315383N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	Silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.40m
30–40	Sand	light grey	fine	well sorted	moist to saturated		
50–120	Sandy clay	orange brown	fine sand	well sorted	moist	low plasticity	
130–200							

Lithological Log

Bore Name:	TP23	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386618E, 6315605N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		
20							
30	Sand	light grey	fine	well sorted	moist		Groundwater encountered @ 0.52m
40							
50							
60							
70							
80	Sandy clay	light grey	fine sand	well sorted	moist	medium to high plasticity	
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP24	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386978E, 6315821N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		No groundwater encountered
20	sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
30							
40							
50							
60							
70							
80							
90							
100							
110							
120	End of hole						
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP25	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386438E, 6314568N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.35m
20							
30							
40							
50							
60							
70	Sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
80							
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP26	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385748E, 6315087N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.45m
20							
30	Sand	light grey	fine	well sorted	moist		
40							
50							
60							
70							
80	Sandy clay	orange/brown	fine sand	well sorted	saturated		
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP27	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385585E, 6315571N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.42m
20–100	sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
100	End of hole						

APPENDIX 8

Treendale Structure Plan
Area 3B, Roelands WA

Site Soil Evaluation

Bio Diverse Solutions

02/08/2022

DOCUMENT CONTROL

TITLE: Site Soil Evaluation – Treendale Structure Plan Area 3B, Roelands WA

Author (s): Chiquita Cramer

Reviewer (s): Mary Holt & Kathryn Kinnear

Job No.: MSC00285-004

Client: Tecon Australia

REVISION RECORD

Revision	Summary	Revised By	Date
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1. Introduction

Bio Diverse Solutions was commissioned by Tecon Australia (surveying and planning) on behalf of their clients to conduct a Site Soil Evaluation (SSE) at the Treendale Structure Plan Area 3B, which consists of Lots 1, 2, 3, 121, 185, 246, 314, 878 and 3315 Treendale Road, Roelands WA, herein referred to as the Subject Site. The SSE has been prepared to support and guide an amendment to the Local Structure Plan. The SSE has also been prepared to support and guide the subsequent rezoning and subdivision of the site. This report details the site soils under late winter conditions and suitability for on-site effluent disposal across the site in relation to the proposed structure plan and future subdivision.

1.1. Alignment to Legislation, Policy and Guidelines

Bio Diverse Solutions has prepared this report aligned to the following legislation:

- *Government Sewerage Policy (2019);*
- *Health Act (1911)* and draft *Health Act (2008);*
- *Country Area Water Supply Act 1947;*
- State Planning Commission, Land Capability Assessment for Local Rural Strategies (1989);
- Code of Practise for the Design, Manufacture and Operation of Aerobic Treatment Units (2001); and
- Australian Standard (AS)1547-2012.

1.2. Suitable Qualified Hydrologist

This SSE has been prepared by Chiquita Cramer, who has 13 years of experience working as a hydrologist, hydrogeologist and environmental consultant.

Chiquita has the following tertiary qualifications:

- Bachelor of Science in Natural Resource Management (University of Western Australia); and
- Graduate Certificate in Hydrogeology (University of Western Australia).

Chiquita worked as a hydrologist and senior hydrologist at JDA Consultant Hydrologists in Perth for 8 years. Her experience includes preparation of multiple local and urban water management strategies, hydrological and hydraulic investigations, surface water and groundwater monitoring reports and hydrogeological reports. Chiquita completed a Graduate Certificate in Hydrogeology and in 2017 joined Bio Diverse Solutions (BDS) to provide expertise in hydrology and hydrogeology to the company. At BDS Chiquita has successfully completed numerous SSE reports for a range of developments at various planning stages. She has also recently attended a workshop on SSE reporting organised by the Department of Health.

1.3. Location

The Subject Site is defined as a portion of or all of Lots 1, 2, 3, 121, 185, 246, 314, 878 and 3315 Treendale Road, Roelands WA within the Shire of Harvey. The site consists of an area of ~215ha and is bound by Raymond Road to the north, the Collie River to the south and agricultural properties to the east and west. The future Bunbury Outer Ring Road (BORR) is currently under construction immediately west of the Subject Site. The location of the Subject Site is shown in Figure 1.

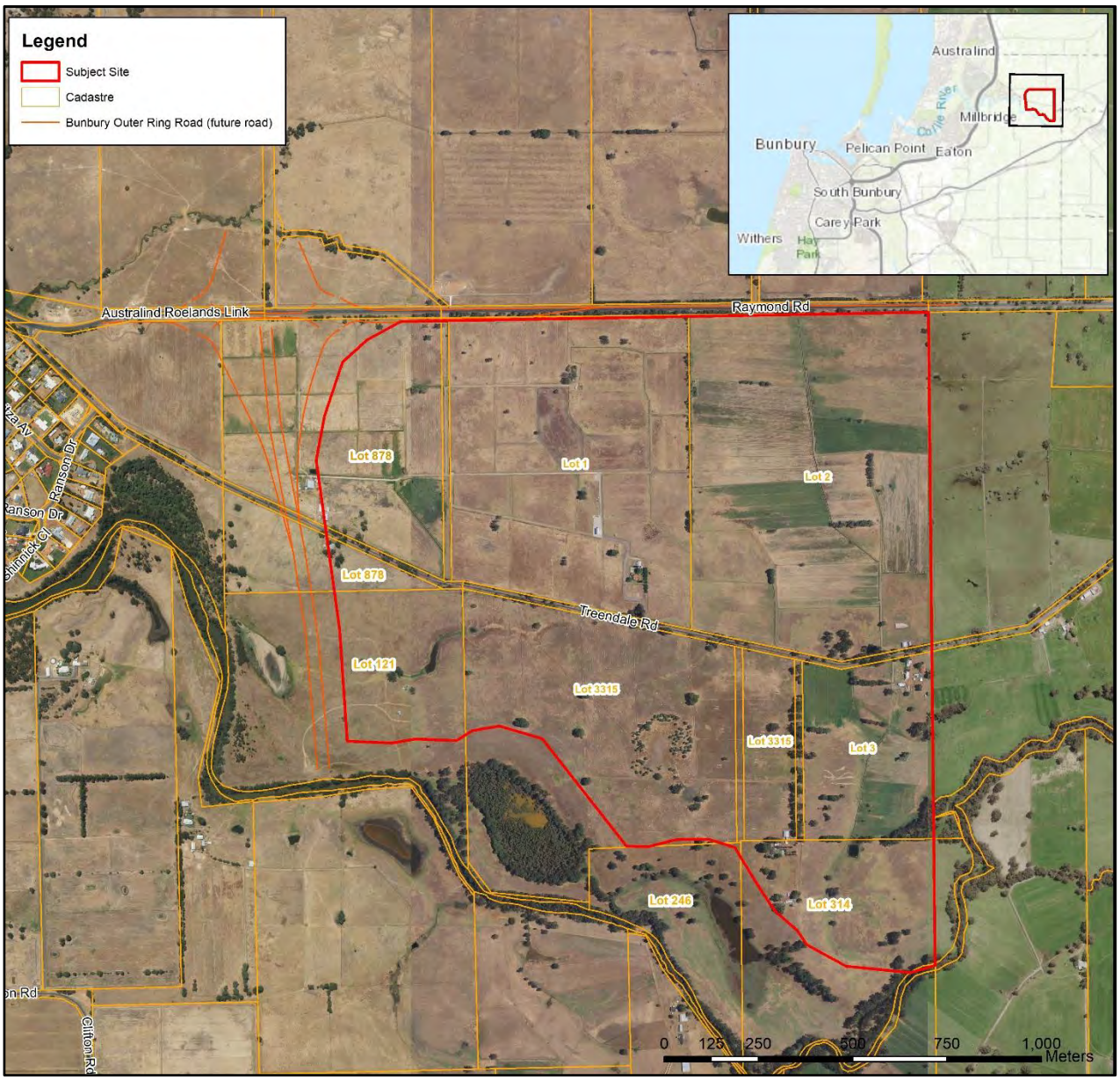


Figure 1: Location plan

2. **Development Proposal**

The portion of the Subject Site north of Treendale Road is zoned as '*Intensive Farming'* and to the south of Treendale Road is zoned as '*General Farming'* according to the Shire of Harvey Local Planning Policy No.1. It is proposed that the Subject Site be rezoned to 'Special Residential' and subdivided into approximately 132 rural residential lots ranging in size from ~1.0ha to 13.3ha. The subdivision concept plan (Tecon Australia, 2022) is shown in Figure 2.

The Landholdings are within the 1996 *Treendale Structure Plan* (Policy Area 3B – 1996 Structure Plan) which was endorsed by the WAPC in February 1996 and applies to a number of properties between Raymond Road and the Collie River. The Landholdings have been designated under the 1996 Structure Plan for future rural residential development.

The Department of Planning, Lands and Heritage (DPLH) has considered the status of the 1996 Structure Plan and has determined that the plan has full legal effect as a document to be given due regard in any decision making.

In noting the status of the 1996 Structure Plan and the advice from DPLH that the 1996 structure plan has full legal affect there is still a need to amend the document to address the implications of the Bunbury Outer Ring Road (BORR) as well as comprehensively addressing environmental and engineering servicing considerations.

The Amended Structure Plan will provide the framework for the coordinated provision and arrangement of the land uses, subdivision and development. It will also inform the provision of a transport network, public open space, public utilities, development standards, community infrastructure and urban water management.

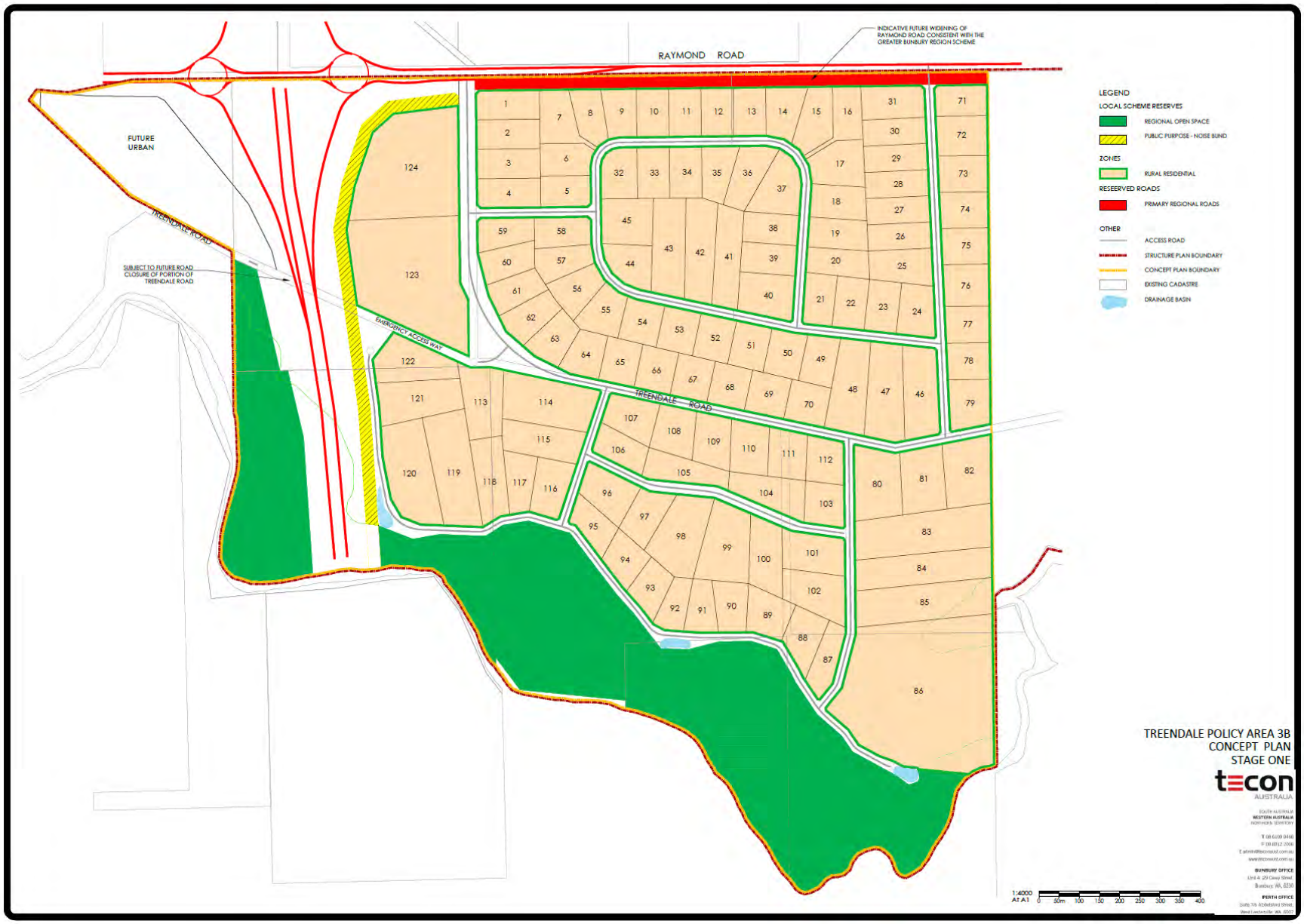


Figure 2: Subdivision concept plan

3. Desktop Assessment

3.1. Topography and slope

The majority of the Subject Site is relatively flat and lies between 14 to 16m AHD. The southern end of the site slopes down towards the Collie River, with the lowest point being 4m AHD in the southeast of the site. Topographic contours (2 metre) are shown in Figure 3.

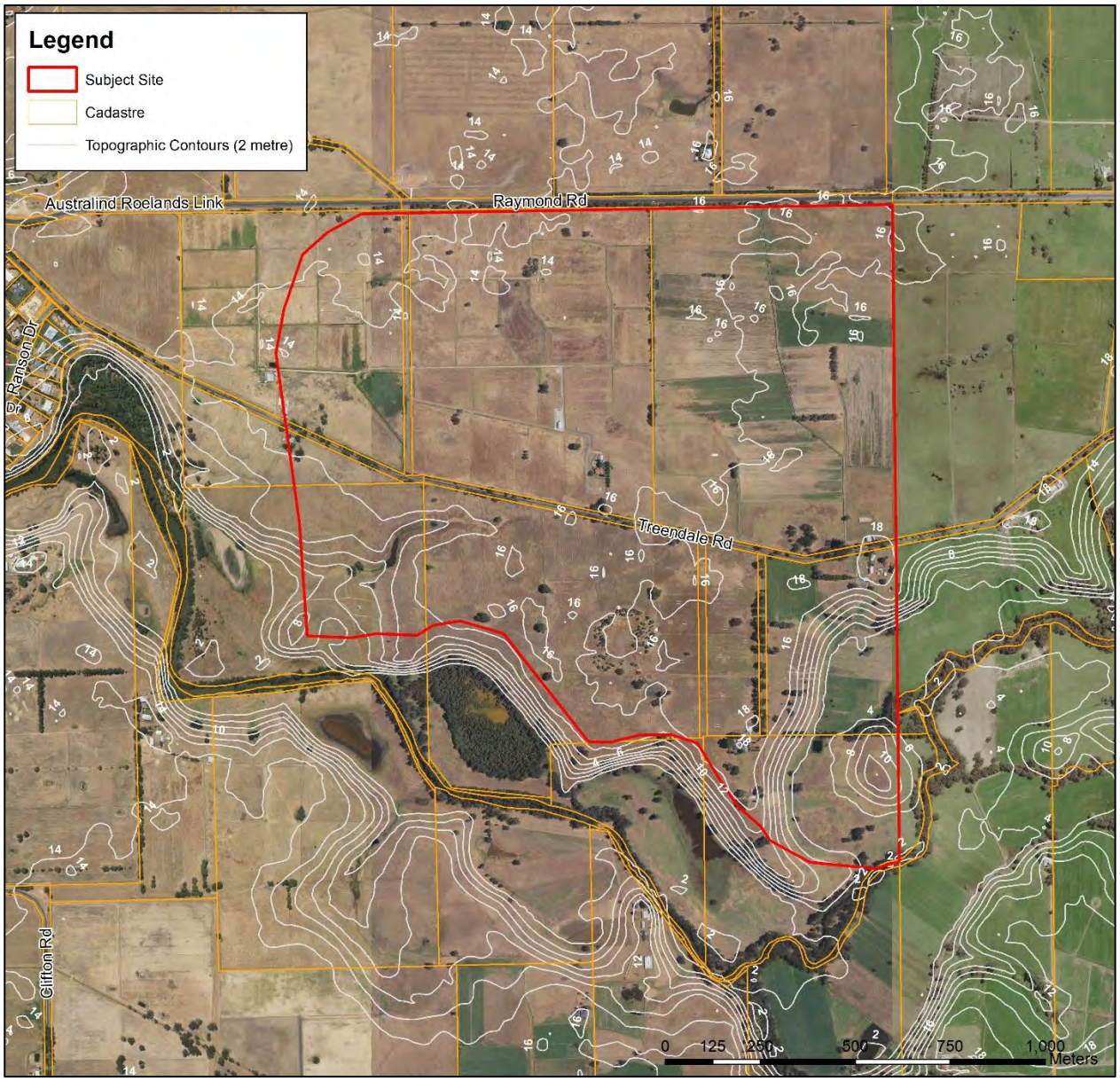
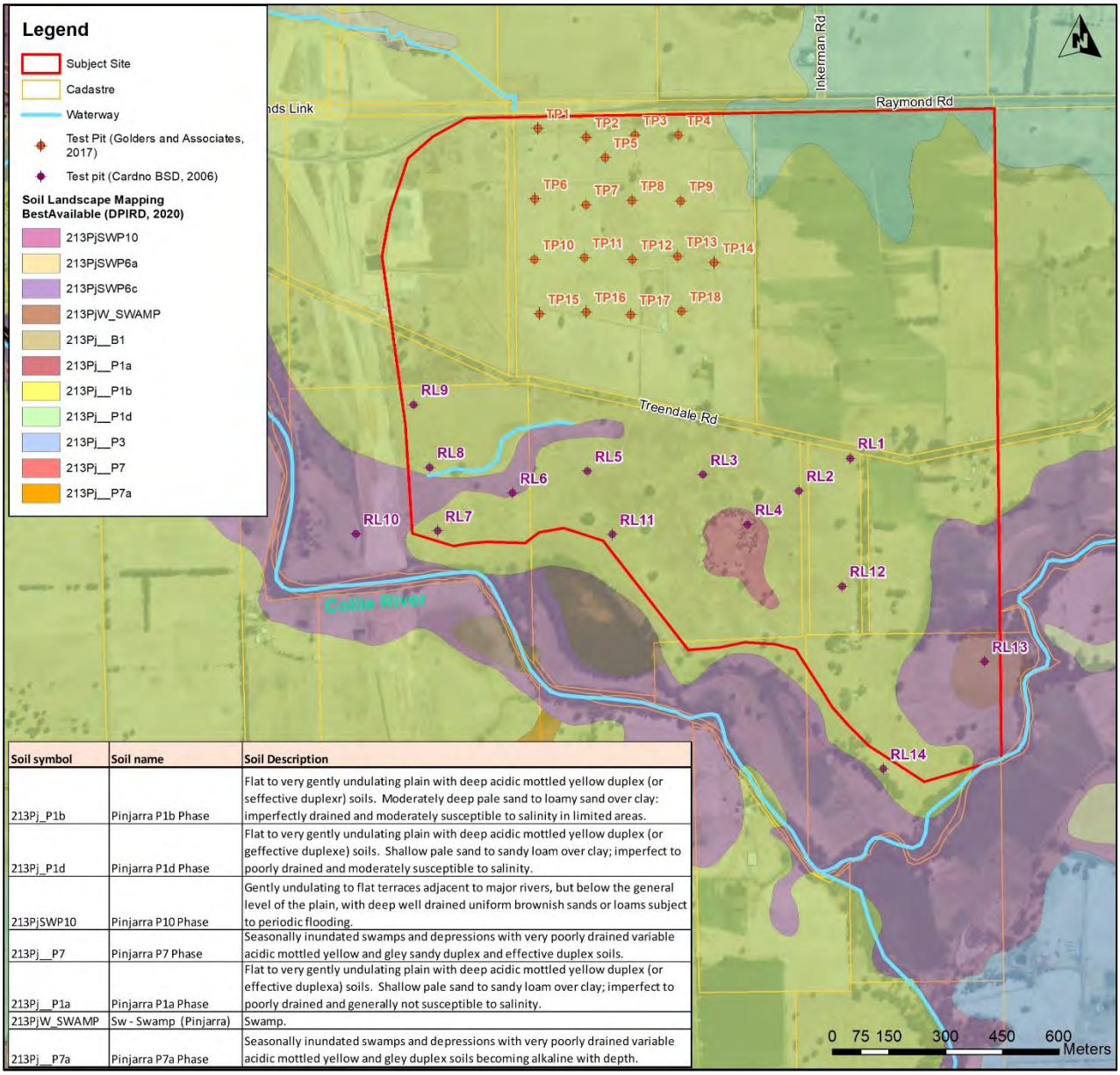


Figure 3: Topography

3.2. Geology and Soils

Soil mapping – Best Available (DPIRD, 2017) shows the Subject Site lies within the Pinjarra System (213Pj). The system is described as "*Swan Coastal Plain from Perth to Capel. Poorly drained coastal plain with variable alluvial and aeolian soils. Variable vegetation includes Jarrah, marri, wandoo, paperbark sheoaks and rudis"*. The Subject Site is also within the Pinjarra Zone (213) and described as having "*Alluvial deposits (early Pleistocene to Recent) between the Bassendean Dunes Zone and the Darling Scarp, colluvial and shelf deposits adjacent to the Darling Scarp. Clayey to sandy alluvial soils with wet areas."* (DPIRD, 2017). The Subject Site is also located in several sub-systems of the Pinjarra System as defined by DPIRD (2017). The sub-systems are shown and described on Figure 4.



Soil symbol	Soil name	Soil Description
213Pj_P1b	Pinjarra P1b Phase	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or seffective duplexr) soils. Moderately deep pale sand to loamy sand over clay: imperfectly drained and moderately susceptible to salinity in limited areas.
213Pj_P1d	Pinjarra P1d Phase	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or geffective duplexe) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and moderately susceptible to salinity.
213PjSWP10	Pinjarra P10 Phase	Gently undulating to flat terraces adjacent to major rivers, but below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding.
213Pj__P7	Pinjarra P7 Phase	Seasonally inundated swamps and depressions with very poorly drained variable acidic mottled yellow and gley sandy duplex and effective duplex soils.
213Pj__P1a	Pinjarra P1a Phase	Flat to very gently undulating plain with deep acidic mottled yellow duplex (or effective duplexa) soils. Shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity.
213PjW_SWAMP	Sw - Swamp (Pinjarra)	Swamp.
213Pj__P7a	Pinjarra P7a Phase	Seasonally inundated swamps and depressions with very poorly drained variable acidic mottled yellow and gley duplex soils becoming alkaline with depth.

Figure 4: Soil mapping

3.2.1 Environmental Assessment and Land Capability Study (Cardno BSD, 2006)

Soil testing was conducted at the Subject Site in the area south of Treendale Road in January 2006 by Cardno BSD as part of an Environmental Assessment and Land Capability Study for the area. The Environmental Assessment and Land Capability Study (Cardno BSD, 2006) report is included as Appendix A and the location of the test pits constructed as part of the investigation are shown on Figure 4.

The investigation included the construction of 14 test pits, with soils at the site found to consist of duplex soils with varying depths (0.2m – 0.7m) of pale quartz sand overlaying dense highly plastic clays in the north of the investigation area. Within the southeast of the site soils were found to be red earths (to 1.3m) overlying hard packed yellow/orange and white/grey clay (RL13 and RL14, as shown in Figure 4). The soil type within the 213Pj_P7 sub-system (as indicated by test pit RL4, Figure 4) was found to consist of dry dense clay over cementitious quartz and laterite. Cardno BSD (2006) found that this test pit location was difficult to excavate and can be considered to be completely impermeable.

3.2.2 Geotechnical Investigation (Golder & Associates, 2017)

Soil testing was also conducted on Lot 1 Treendale Road (Figure 1), to the north of Treendale Road by Golder and Associates in January 2017 as part of a Geotechnical Investigation. The investigation is included as Appendix B and the soil testing locations are shown in Figure 4. The investigation included the construction of 18 test pits to the depth of 1.3 to 2.5 metres. Based on the field investigation results, soils across the site are also summarised by Golder and Associates (2017) as comprising of duplex soils, with Golder and Associates describing them as:

- Silty sand (topsoil): fine to medium grained, black, ~10-15% low plasticity fines, trace organics, loose to medium dense, moist to dry, extending from the ground surface to depths of between about 0.15 m and 0.2 m, overlying;
- Clayey sand: fine to medium grained, yellow, grey, low to medium plasticity, generally medium dense to dense, dry to moist, containing weakly to well cemented (laterised) zones, extending to depths of between 0.4 m and the maximum depth investigated of 2.5 m, overlying;
- Sandy clay: medium to high plasticity, fine to medium grained, grey with red and orange mottling, generally stiff to very stiff, containing weakly cemented zones, extending to the maximum depth investigated of 2.5 m (Golder Associates, 2017).

3.3. Surface Hydrology

The Subject Site is generally flat and as such the majority of rainfall falling on the site either ponds at surface or within agricultural drains that have been constructed across the site. Any discharge off the site north of Treendale Road is in a north westerly direction towards a seasonal creek line within agricultural land to the northwest of the Subject Site. The seasonal creek ultimately discharges to the Collie River further west of the Subject Site. Stormwater runoff from the southern portion of the Subject Site is to the south towards the Collie River and adjoining flood plains between the river and the Subject Site. The Collie River ultimately discharges to Leschenault Estuary to the west. The surface hydrology of the Subject Site is shown in Figure 5.

There are no major water bodies within the Subject Site. There are several manmade farm dams within the site and one naturally formed water body in the southwest of the site within a valley/creek system. There are also some areas across the site that are subjected to seasonal inundation given the flat nature of the site and its close proximity to the Darling Range to the east.

The Subject Site is located within the Coastal Plain hydrological zone (HZ15_CP) (DPIRD, 2018) and described as; '*Coastal & fixed sand dunes & calcarenite. Non-calcareous sands, podsolised soils with low-lying wet areas. Further inland, alluvial deposits, colluvial deposits adjacent to the Darling Scarp. Clayey to sandy alluvial soils with wet areas.'.*

The Subject Site is also located within one hydrographic catchment being the Leschenault Estuary-Lower Collie Catchment and one hydrographic sub-catchment being the Lower Collie Tribs (DWER, 2018).

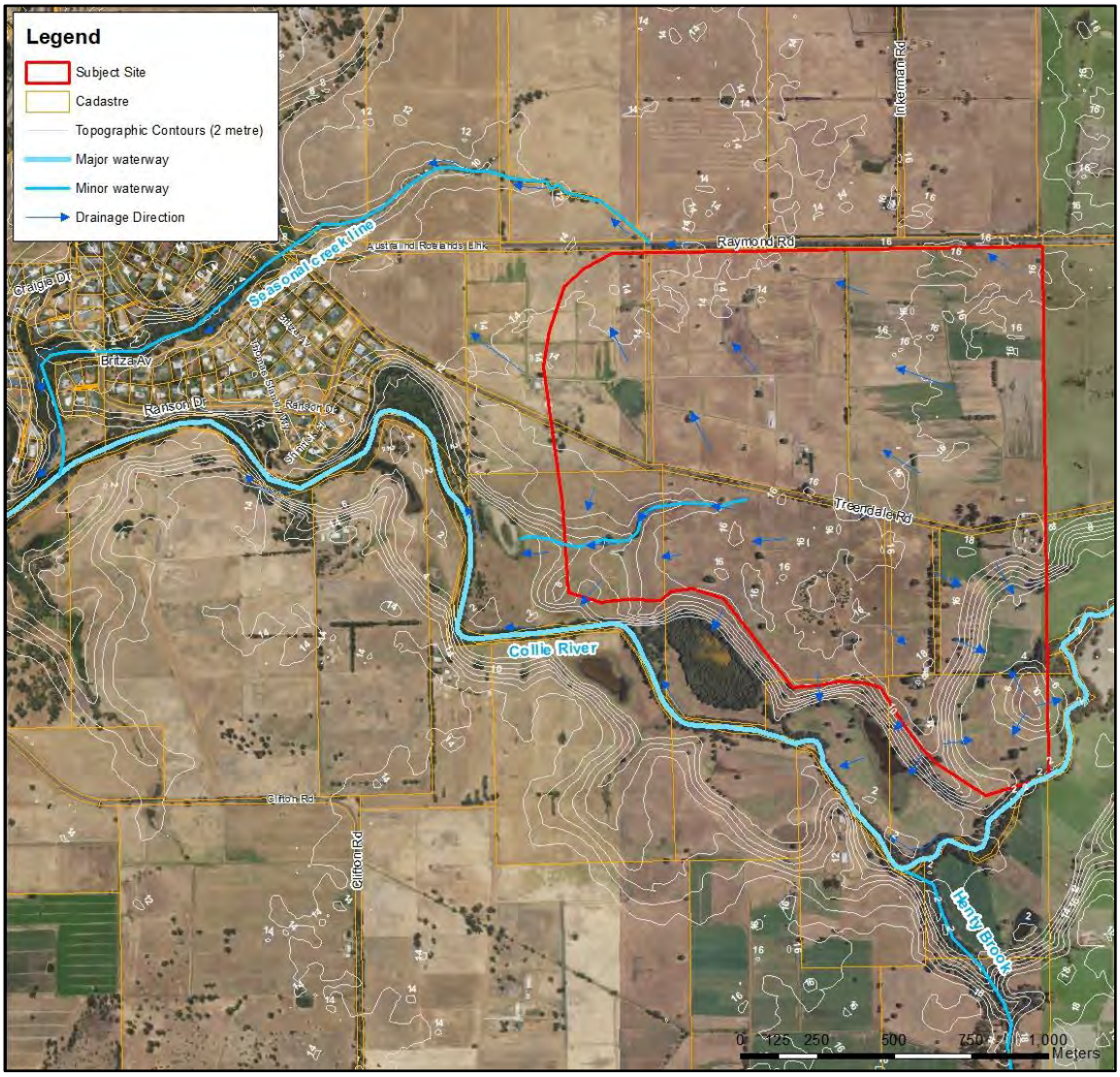


Figure 5: Surface water hydrology

3.4. Hydrogeology and Groundwater

Australian Geoscience Mapping and Department of Water and Environmental Regulation 250K Hydrogeological mapping (DWER, 2001a) places the Subject Site within one hydrogeological zone being Qpgs with the aquifer described as; '*Surficial aquifer - karstic or unconsolidated, extensive or local major to minor groundwater resources'* and the geology described as; '*Guilford Formation - alluvial sand. clay and gravel with minor estuarine and shallow marine lenses Sand member'.* 250K Hydrogeology mapping is shown in Figure 6.

The Subject Site is not situated within a Priority Drinking Water Catchment Area (DWER PDWSA Dataset, 2001). Desktop analysis of the site indicates that the nearest designated Public Drinking Water Source Area (PDWSA) is the "Bunbury Water Reserve" as defined by the *Country Areas Water Supply Act 1947* located approximately 12kms southwest of the Subject Site.

The Department of Water and Environmental Regulation Water Information Reporting Tool (DWER, 2018) shows 5 domestic groundwater bores/wells are detected within a 500m radius of the Subject Site, the locations of the 5 domestic bores are shown on Figure 6. Of the 5 bores 1 is located within the Subject Site in the central north and the nearest domestic bore to the Subject Site is located approximately 35m to the east of the Subject Site boundary in the southeast.

3.2.3 Groundwater

Groundwater was not encountered in any of the test pits (to a depth of 2-4 metres) constructed during the assessment conducted by Cardno BSD in January 2006 on the area of Subject Site to the south of Treendale Road. While the soils at some locations were observed to be moist, the water table was not present. Groundwater was encountered at one location (TP8 at a depth of 2.5m BGL) during the geotechnical investigation conducted by Golders and Associates in January 2017 on Lot 1 Treendale Road.

Monthly groundwater monitoring (levels) was conducted by 360 Environmental from December 2016 to August 2017 at 7 groundwater monitoring locations within the area of the Subject Site south of Treendale Road. The monthly depth to groundwater for each monitoring bore is presented in Table 1 and the location of the groundwater monitoring bores is shown in Figure 6.

Table 1: Groundwater monitoring levels Dec 16 to Aug 17 (360 Environmental)

Bore	Bore Depth	Monitoring event								
		Dec-16 (m BGL)	Jan-17 (m BGL)	Feb-17 (m BGL)	Mar-17 (m BGL)	Apr-17 (m BGL)	May-17 (m BGL)	Jun-17 (m BGL)	Jul-17 (m BGL)	Aug-17 (m BGL)
MB1	6	5.11	5.33	5.21	5.06	5.63	5.88	6	5.76	3.54
MB2 shallow	6	dry	dry	dry	dry	dry	dry	dry	dry	dry
MB2 deep	20	5.39	12.16	12.29	12.35	12.45	12.46	12.44	12.3	11.63
MB3	6	dry	dry	dry	dry	dry	dry	dry	dry	3.15
MB4	6	dry	dry	dry	dry	dry	dry	dry	dry	4.95
MB5	6	4.9	4.8	5.05	5.23	5.55	5.76	5.89	5.52	2.13
MB6 shallow	6	dry	dry	dry	dry	dry	dry	dry	dry	3.75
MB6 deep	20	5.31	8.21	8.26	8.26	8.37	8.25	8.1	8	7.35
MB7	6	5.81	1.4	1.56	1	1.6	0.98	1.1	0.74	0.73

Groundwater was not found to be close to surface (within 2m) at all monitoring bores except MB7 where the highest groundwater level was found to be 0.73m BGL recorded in August 2017.

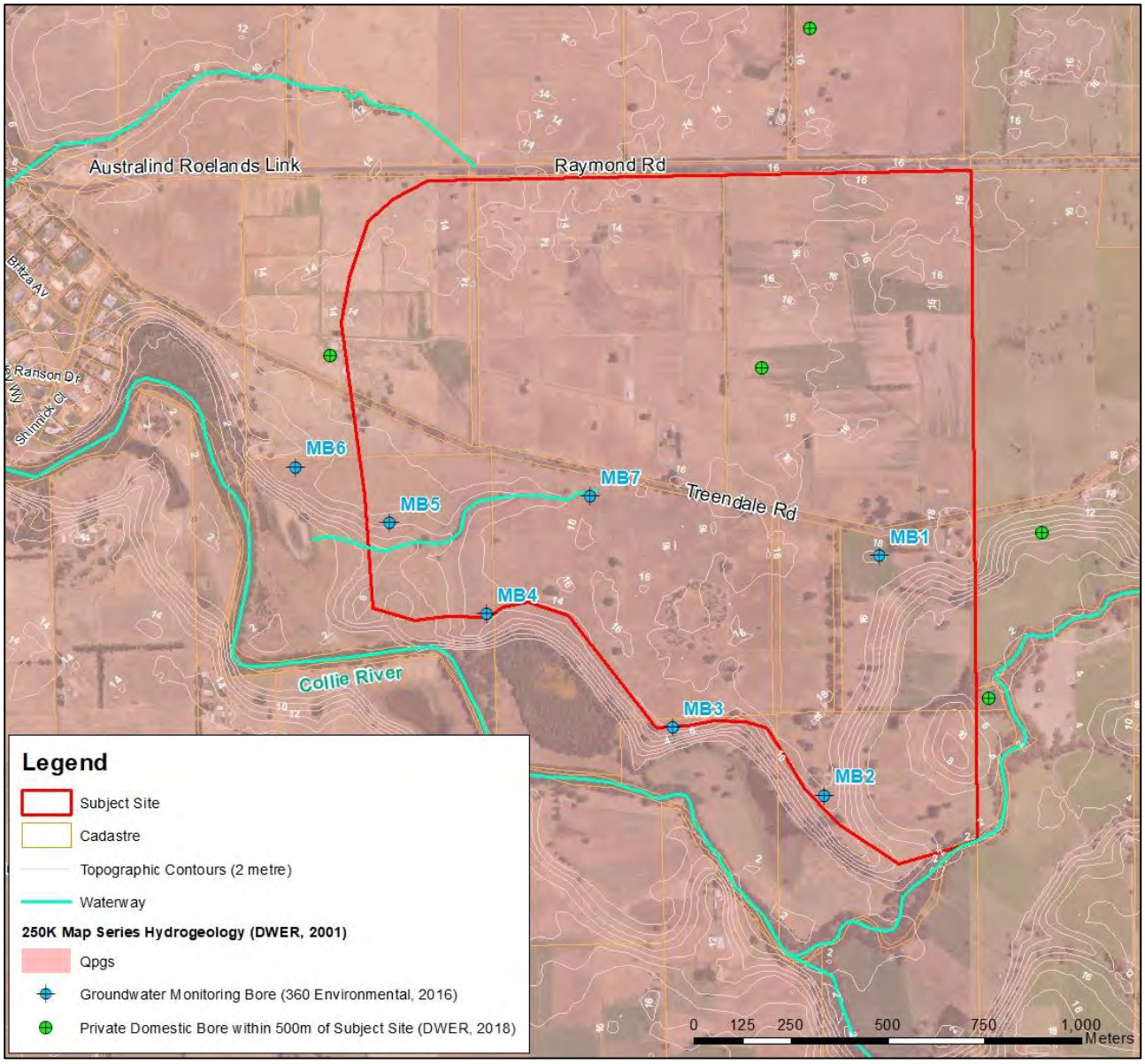


Figure 6: Hydrogeology and groundwater

3.5. Flooding Potential

The majority of the Subject Site is elevated and as such not subjected to flooding from the Collie River or other nearby waterways or water bodies.

The site is however described as a palusplains (seasonally waterlogged flats) due to its flat nature and proximity to the Darling Range (approximately 3.5kms east), receiving both stormwater runoff and groundwater through flow from the range. As such the Subject Site is subjected to seasonal inundation and water logging.

3.6. Environmentally Sensitive Areas

The nearest Environmentally Sensitive Area (ESA) is located approximately 175m west of the Subject Site being a section of riparian vegetation fronting the Collie River. There is also another ESA further west (approximately 820m from the Subject Site) comprising of riparian vegetation fronting a tributary of the Collie River. Both ESAs are downstream of the Subject Site and as such impacts on the ESAs are to be considered.

3.7. Wetlands

The Subject Site is located within the Leshenault Inlet Management Area which is designated as a Waterways Conservation Act Management Area (WALGA, 2020a).

The southern boundary of the Subject Site is bounded by the Collie River and the Collie River floodplain. The wetlands identified through the Geomorphic Wetlands dataset of the Swan Coastal Plain is shown in Figure 7. Three “Multiple Use” geomorphic wetlands cover the majority of the Subject Site (UFI 15223, 1736 and 1719) which are classified as palusplain, floodplain and sumplands respectively.

One “Conservation” wetland (UFI 1734) is located approximately 230m to the west of the Subject Site, this wetland is classed as a floodplain.

One “Resource Enhancement” wetland (UFI 1870) is located approximately 100m south of the Subject Site and is classed as a sumpland, as shown in Figure 7.

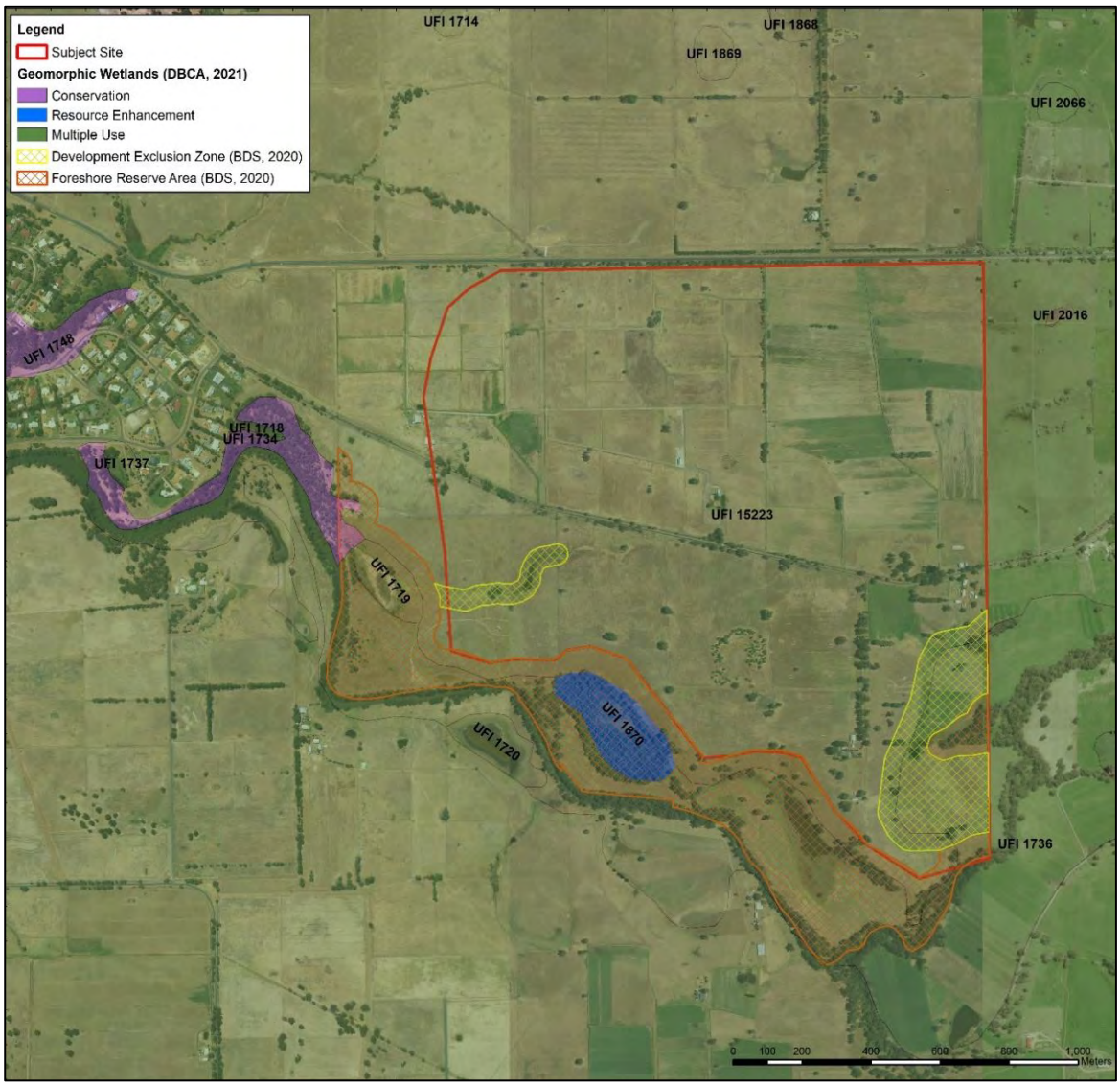


Figure 7: Wetland mapping

A Wetland Management Plan (WMP) for the Subject Site and the adjacent wetlands has been prepared by Bio Diverse Solutions (2022). The WMP identifies the potential impacts from the proposed development and management strategies proposed to protect and enhance the wetlands. It also identifies a proposed foreshore area and a development exclusion zone (as shown on Figure 7) to allow adequate setback and protection of the adjacent wetlands. This SSE is in accordance with the Wetland Management Plan (BDS, 2022).

3.8. Sewage Sensitive Areas

The Subject Site is located in a Sewage Sensitive Area according to the Department of Planning, Lands and Heritage Sewage Sensitive Area Mapping (DPLH, 2019b). Sewage Sensitive Area mapping is shown in Figure 8.

The Government Sewerage Policy (DPLH, 2019b) describes Sewage Sensitive Areas as; '*Estuary catchments on the Swan and Scott Coastal Plains'* and '*within one kilometre up-groundwater- gradient and 250 metres down-groundwater-gradient of a significant wetland; or where the groundwater gradient is unknown or seasonably variable within one kilometre of the significant wetland'.*

The Subject Site is located on the Swan Coastal Plain and the western portion of the site is located within 1km upgradient of a significant wetland.

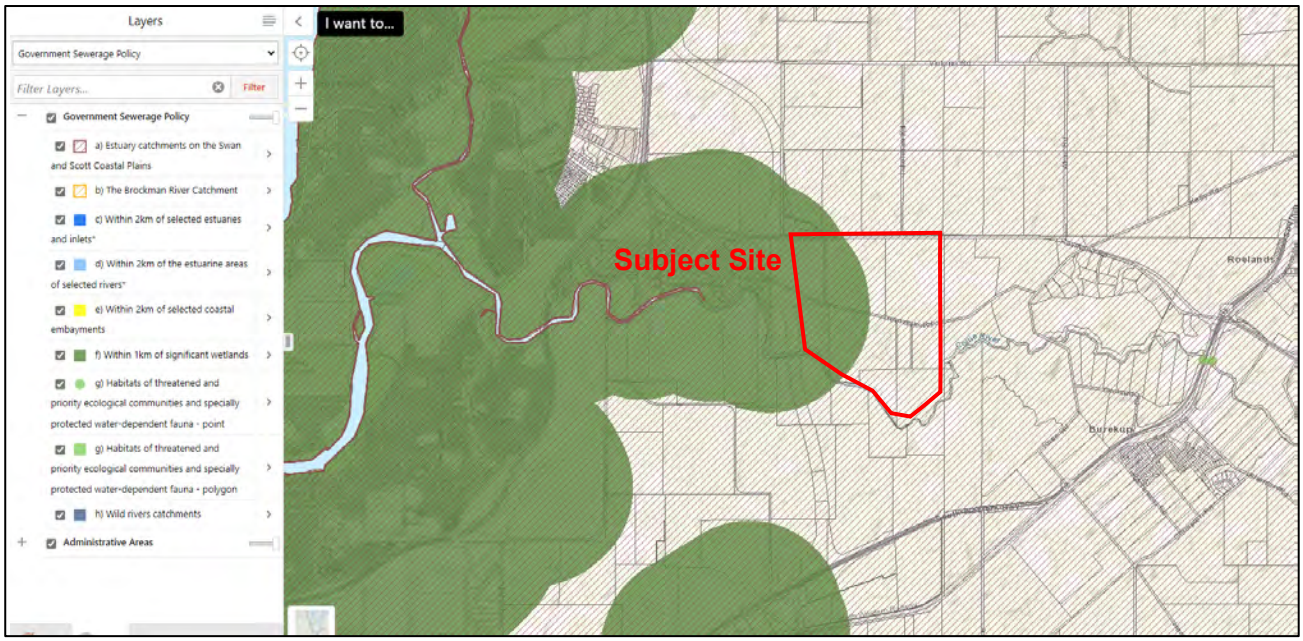


Figure 8: Sewage sensitive area mapping (DPLH, 2019b)

4. Soil Testing Results

Site soil testing was conducted on the 20th and 21st September 2021 by Bio Diverse Solutions under late winter conditions. Testing involved site soil analysis, photographic recording, logging of soil types, measuring of water table and laboratory PRI testing. In total, 27 test holes were constructed to varying depths up to 2m and left open for a minimum of 1 hour to identify any water table present. The soil logs for the site are included in Appendix C. Test hole locations are shown in Figure 9.

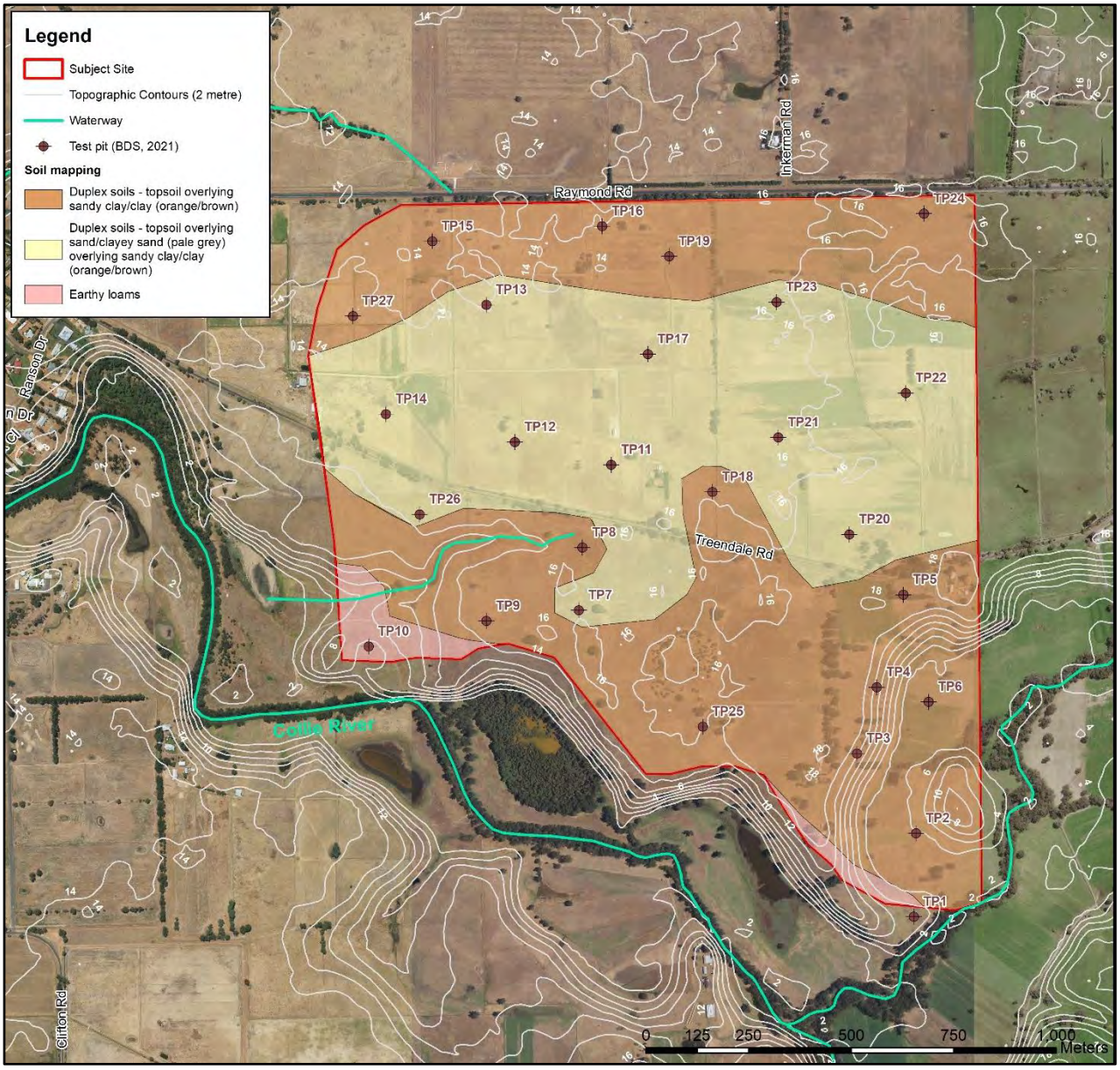


Figure 9: Soil testing locations

The 27 test pits, in addition to the 14 Cardno BSD test pits and the 18 Golder Associates test pits revealed that soils across the Subject Site varied somewhat with site and topography, however generally soils across the Subject Site comprised of duplex soils with varying depths of sand and clay. The general soil profile across the site comprised of:

- Silty sand/loam (topsoil): fine grained, well sorted, dark grey/brown, moist to dry, extending from the ground surface to depths of between 0.2 m and 0.4 m, overlying;

- Sand/clayey sand: fine grained, well sorted, grey to light grey, moist to saturated, extending from beneath the topsoil to depths generally between 0.4 and 0.6m BGL. This layer was only present through the central portion of the Subject Site, as shown by soil mapping presented in Figure 9, overlying;
- Sandy clay: fine grained sand, orange/brown. Plasticity usually transitioned from low to medium close to surface (up to 0.6m BGL) particularly where no sand layer was present to medium to high with depth.

In addition to the above soil type, areas adjacent to the Collie River comprised of earthy loams, with soil profiles consisting of:

- Loam: fine grained, well sorted, dark brown, dry. Extending from the ground surface to depths of approximately 0.6m, overlying;
- Sandy clay loam: low plasticity, fine grained sand, red/brown. Extending to the depth of hole at 2 metres.

Soil mapping based on the test pit results is presented in Figure 9.

4.1. Phosphorous Retention Index

Phosphorous Retention Index (PRI) is a measure of the soils ability to absorb and treat nutrients within the soil (i.e., Soil microbe disinfecting ability). Soils with a PRI less than 1 have a very poor ability to treat effluent waters, whilst soils with a PRI of >5 having a high ability to treat effluent waters. PRI testing was conducted at TP 9, TP12, TP13, TP16, TP18 & TP21. The PRI results are presented in Table 2.

Table 2: Phosphorus Retention Index Results (CSBP, 2021)

Test Pit	Depth (mm)	Soil Type	Phosphorus Retention Index
TP9	500-1000	Sandy clay	43.9
TP12	200-600	Sand	14.3
TP13	590-880	Sandy clay with gravel	451.4
TP16	500-700	Sandy clay	352.4
TP18	600-800	Sandy clay	>1000
TP18	200-500	Sandy clay	169.5
TP21	400-700	Silty sand	8.1

PRI within the subsurface layers across the Subject Site was found to be high to extremely high, as shown in Table 2. PRI was found to be consistent with soil type with the soils containing a higher clay content having a higher PRI.

4.2. Waterlogging and Seasonal Inundation

The test pits constructed by BDS on the 20th and 21st September 2021 showed a shallow (<0.5m BGL) perched groundwater table across much of the Subject Site. Figure 10 shows the test pits in which the water-table was found to be present at <0.5m BGL. The exact water-table level recorded at each test pit is shown on the soil testing logs included as Appendix C. Some areas of the Subject Site where also found to be seasonally inundated during the site investigation. The approximated areas of water logging and seasonal inundation found at the Subject Site during the site investigation are shown in Figure 10.

It shall be noted that the rainfall received in the Roelands area for the months of Feb-Jul 2021 prior to the site soil investigation was significantly higher than average.

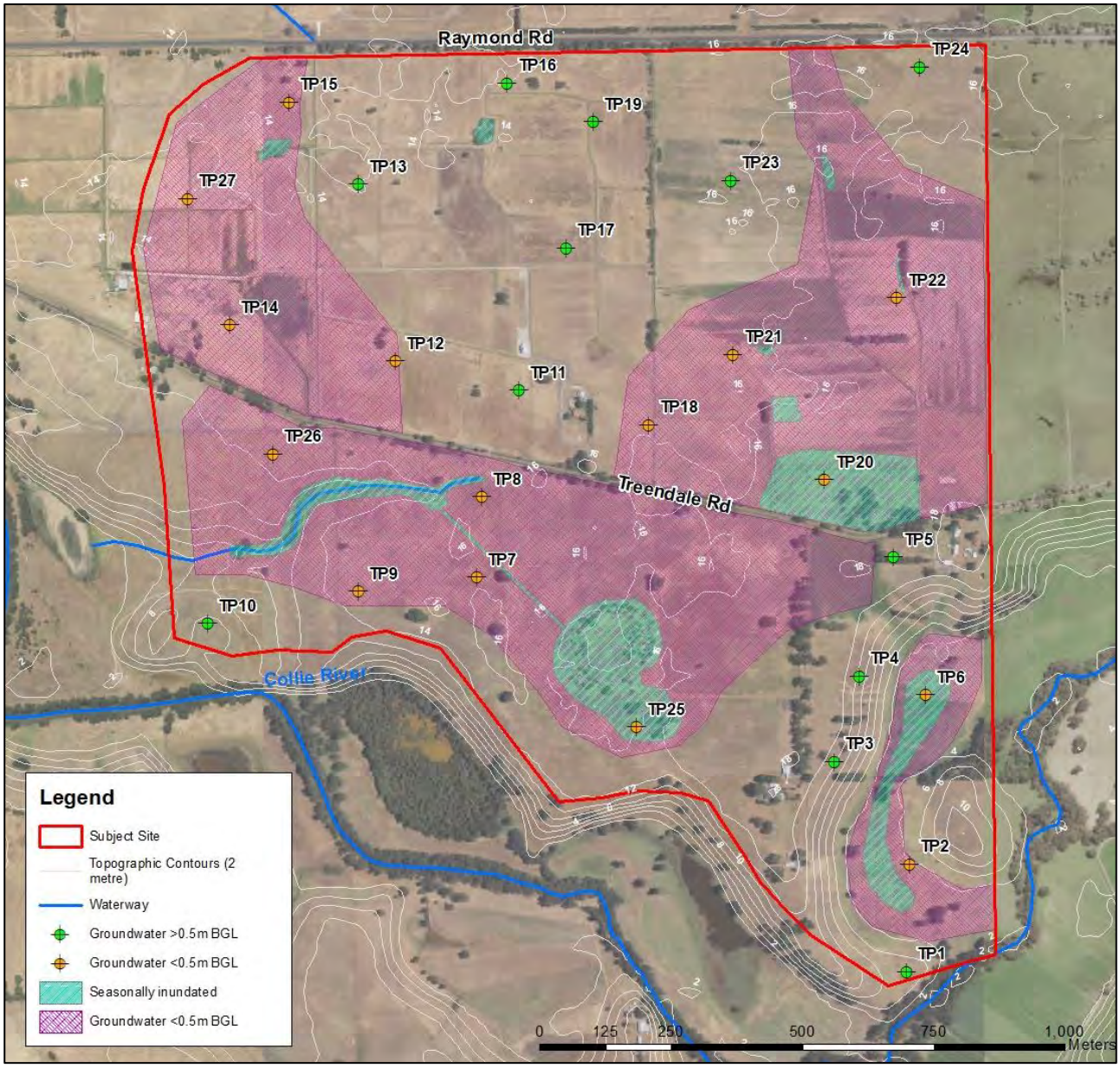


Figure 10: Waterlogged and seasonally inundated areas

5. Site Suitability

The health and environmental requirements for wastewater treatment and disposal for developments not serviced by deep sewerage systems are outlined in the Government Sewerage Policy (GSP*)* (DPLH, 2019a). The Subject Site is situated in a Sewage Sensitive Area (DPLH, 2019b) and does not have access to deep or reticulated sewerage. The GSP (DPLH, 2019a) states minimum requirements apply for all on-site sewage disposal systems. Compliance to the minimum requirements outlined in the GSP is summarised below and outlined in Table 3.

Summary of compliance to the GSP minimum requirements:

- Soils across the Subject Site varied with site and topography. Generally, the soil types encountered on site were found to be duplex soils consisting of topsoil overlying sands or clayey sands to varying depths overlying sandy clays/clays. The soil types across the Subject Site, as identified by Cardno BSD (2006), Golder Associates (2017) and BDS (2021), have been categorised consistent with soil categories presented in Table 3 of the GSP (DPLH, 2019). The soil categories identified across the site include loams, clay loams, light clays and heavy clays, the soil categories and the proposed lots that are within each soil category are shown in Figure 11. The size of the Land Application Area for each lot shall be consistent with the respective soil category as identified in Table 3 of the GSP (2019). Soil types and associated soil categories shall be confirmed at a lot scale prior to development in the exact location of the proposed Land Application Area to ensure the correct land application area size is utilised and adequate infiltration is achievable.
- The high PRI levels found in the sub-surface layers at the Subject Site are suitable for assisting the process of nutrients and contaminants being fixed by soil microbes.
- The slopes across the site generally do not exceed the minimum grade requirements (1:5) as outlined in Table 3 of the Draft Government Sewerage Policy. The Subject Site is generally flat except in the southeast of the site where slopes descend steeply towards the Collie River, slopes here are approximately 1:10. Construction of land application areas on the steeper sections of the hillside in the southeast shall be avoided where possible.
- The depth to the seasonal high water-table across the site varied from 0.22m to not encountered to 2 metres during the site investigation (BSD, 2022). The minimum separation required between the high water-table and effluent disposal application in Sewage Sensitive Areas is 1.5m. Where separation to groundwater is <1.5m (as seen across much of the site) imported fill and special design requirements (as discussed in Section 6) will be required to ensure the separation requirement is met. Where the depth to the high water-table is <0.5m BGL it is recommended that the building envelopes on proposed lots be filled with suitable imported fill material so that a minimum of 0.5m of separation to the seasonal high water-table is achieved prior to subdivision. Further groundwater investigation may be required to better identify the areas that require filling to achieve 0.5m separation to high water-table. Following subdivision, it shall be the responsibility of the future lot owner to ensure the 1.5m separation between effluent disposal application and the high water-table requirement is met. This separation requirement is applicable to the land application area only.

  It should be noted that rainfall in the months (April-July) prior to the site investigation was higher than average and as such the depth to the high water-table across the site was notably less than during an average late winter period.
- Where the depth to the high water-table is <0.5m the lots shall be a minimum size of 1ha.
- The nearest domestic groundwater bore to the Subject Site is approximately 35m to the east. A Development Exclusion Zone applies to the area within the Subject Site adjacent to this nearest domestic bore. The domestic bore within the Subject Site shall be decommissioned as part of

development works. The minimum separation requirement between effluent disposal application and domestic production bores is >30m, this is achievable at the Subject Site. Any future proposed domestic bores shall be situated at least 30m from any onsite effluent land application areas.

- There is one naturally occurring waterway within the Subject Site, a seasonal creek line in the southwest of the site, the creek line also has a dammed section. A 100m setback from the creek line to any land application areas is proposed. It is also proposed to revegetate the creek line with sedges and shrubs, the proposed revegetation area is shown in Figure 11. Both the Collie River and a tributary of the Collie River (in the northwest) are in close proximity to the Subject Site, a 100m setback between Land Application Areas and the Collie River/Tributary shall apply to the future proposed lots. Suitable Land Application Areas are achievable on each proposed lot given the 100m setback requirement to the waterways, as shown in Figure 11.
- It is recommended a 10m setback from the lot boundaries to all land application areas be applied.
- A 20m setback from the road reserve to land application areas is recommended to provide adequate separation to any proposed roadside drains.

The areas of the Subject Site identified as suitable for onsite effluent disposal are shown in Figure 11.

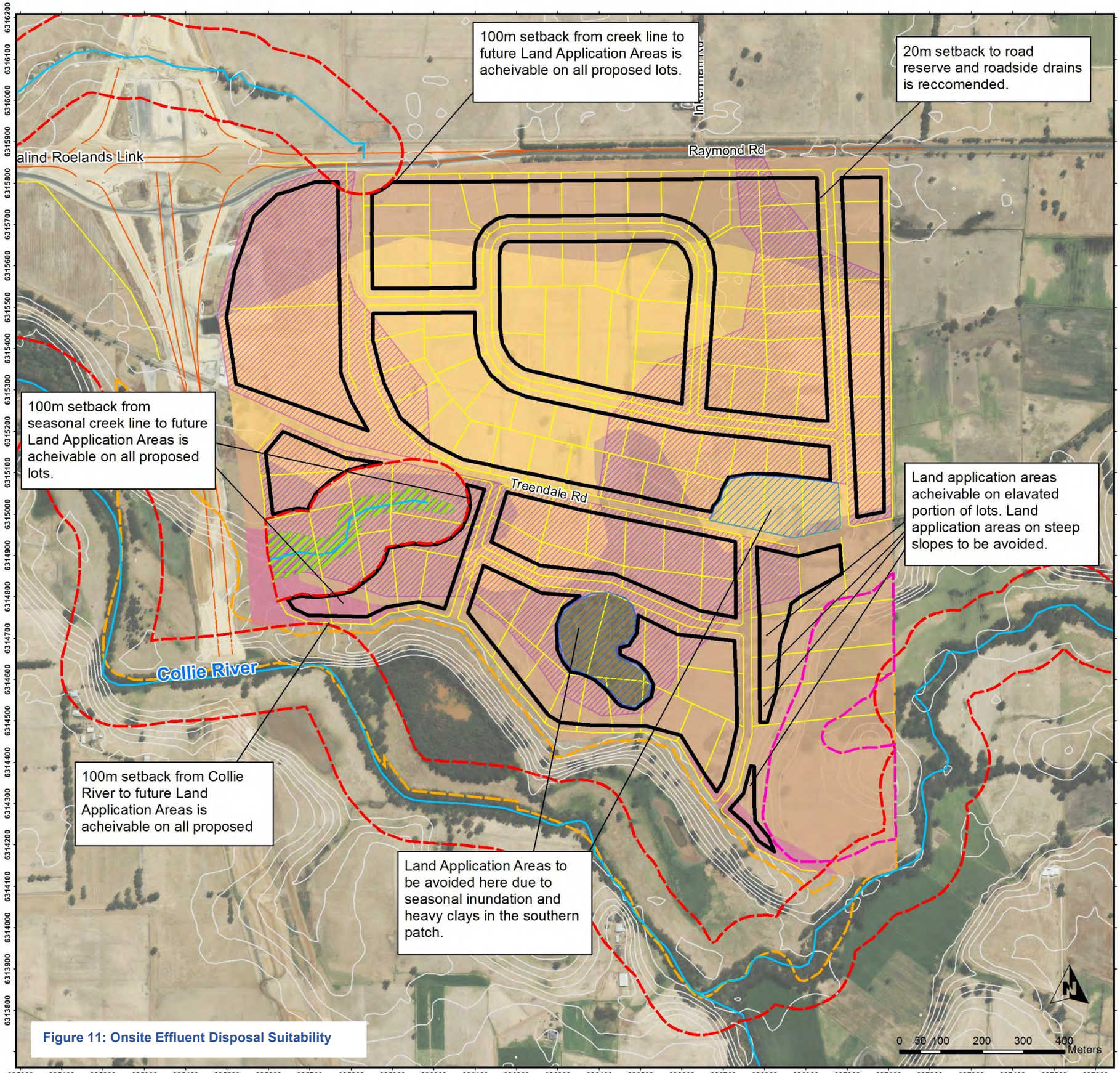


Figure 11: Onsite Effluent Disposal Suitability

This BAL Plan was prepared by:
Kathryn Kinnear, Bio Diverse Solutions
Accreditation No: BPAD30794
Jurisdiction: Level 2 - WA

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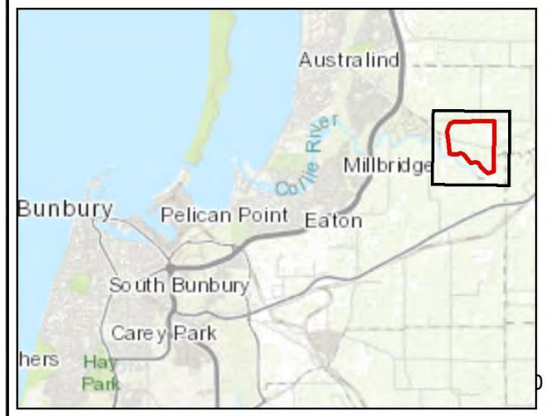

Legend

- Proposed lot layout
- Topographic Contours (2 metre)
- Waterway

Soil mapping

- Light clays
- Clay loams
- Loams
- Heavy clay
- Development Exclusion Zone (BDS, 2020)
- Foreshore Reserve Area (BDS, 2020)
- 100m Setback to waterway
- Area suitable for effluent disposal
- Proposed revegation area
- Groundwater within <0.5m BGL, fill required for building envelopes prior to subdivision.
- Seasonally inundated - avoid land application areas

Scale
1:9,000 @ A3
GDA MGA 94 Zone 50

CLIENT
Tecon Australia
Treendale Structure Plan, Treendale Road
Roelands, WA 6226

Figure 11: Onsite effluent disposal suitability

BAL Assessor	QA Check	Drawn by
CC	KK	CC
STATUS	FILE	DATE
FINAL	MSC0285-004	01/08/2022

Table 3: Minimum requirements for all on-site wastewater disposal systems and design specific standards (DPLH, 2019a)

Site Feature	Minimum Requirement	Requirement met
Separation from waterways	a wellhead protection zone or on Crown land within a reservoir protection zone; 100 metres of the high-water mark of a reservoir or 100 metres of any bore used for public drinking water supply where: — a wellhead protection zone or reservoir protection zone has not been assigned; or — where existing lots would be rendered undevelopable by the wellhead protection zone.	Yes The Subject Site is not located within the vicinity of a Priority Drinking Water Source Area (PDWSA) and associated wellheads. The nearest PDWSA is 12kms away being the Bunbury Water Reserve.
	30 metres of a private bore used for household/ drinking water purposes.	Yes The nearest existing private bore according to the Water Information Reporting Tool (DWER, 2019) is 35m east of the Subject Site boundary. The area within the Subject Site adjacent to this bore is a development exclusion zone with the proposed land application areas >300 metres from the bore. It is proposed the one bore within the Subject Site be decommissioned as part of development works. Any future proposed domestic bores shall be located a minimum of 30m from the designated land application areas.
	100 metres of a waterway or significant wetland and not within a waterway foreshore area or wetland buffer. The separation distance should be measured outwards from the outer edge of riparian or wetland vegetation.	Yes There is a minor creek line within the southwest of the Subject Site. A setback of 100m from the creek to land application areas is proposed. A 100m setback to Land Application Areas from the Collie River in the south and the Collie River tributary to the northwest of the Subject Site is achievable within the proposed lots.
	100 metres of a drainage system that discharges directly into a waterway or significant wetland without treatment.	Yes There are no other major drainage systems (additional to those mentioned above). It is proposed that a 20m setback be applied between the road reserve and land application areas on lots to allow adequate separation to the roadside drains.
	Any area subject to inundation and/or flooding in a 10 per cent Annual Exceedance Probability (AEP) rainfall event.	Yes The Subject Site is not subjected to flooding in a 10% AEP rainfall event from the adjacent waterways. Areas subjected to seasonal inundation shall be avoided for land application areas. Areas subjected to seasonal inundation are shown on Figure 10 and 11.
Separation from groundwater – outside of public drinking water source areas.	Where land is not within a public drinking water source area or a sewage sensitive area, the discharge point of the on-site sewage system should be located the following distances above the highest groundwater level: • for loams and heavy soils, at least 0.6 metres • for gravels, at least one metre • for sands, at least 1.5 metres. Where a nutrient retentive secondary treatment system is used, at least 0.6 metres.	Yes The minimum separation required between the high water-table and onsite effluent disposal in Sewage Sensitive Areas is 1.5m. The high-water table was encountered at <1.5m BGL at several test pit locations. Imported fill and/or special design requirements (as discussed in Section 6) will be required across the site. It is recommended that building envelopes be filled to achieve a minimum of 0.5m separation to the high water-table prior to subdivision. It shall be the responsibility of the future lot owner to achieve the minimum separation requirement of 1.5m between land application and the high water-table as this requirement is best achieved at a lot scale based on preferred location of land application area.

Table 3 continued.

Site Feature	Minimum Requirement	Requirement met
Land Application Area	A land application area should be provided for all development in accordance with tables 2 and 3 of this schedule for the disposal of sewage.	Land application areas shall be located in an area deemed suitable for onsite effluent disposal (Figure 11). The location of the land application areas shall be confirmed upon final design of the development. Land application areas shall be calculated in accordance with the Government Sewage Policy and AS/NZS 1547:2012 as discussed in Section 6.
	The land application area includes the area restricted to the distribution of treated sewage only and should be kept free of any temporary or permanent structures.	Yes The proposed land application areas shall be kept free of any temporary or permanent structures. The land application areas shall be placed in an area so that requirements are met. Site plan to be forwarded to the Shire of Harvey/Department of Health prior to development approval.
	Activities within the land application area shall not interfere with the function of the current and future land application system and people should avoid potential contact with effluent residues. Unless allowed for in the design, the land application area) should: • not be built on or paved in a manner which precludes reasonable access; • not be subject to vehicular traffic (other than a pedestrian-controlled lawnmower); • not be subject to regular foot traffic such as pathways and clothes line areas; and • should be kept in a manner which enables servicing and maintenance of the disposal system.	Yes Future land application areas shall be placed a sufficient distance to areas that are utilized for activity or pedestrian traffic. The land application areas for each lot shall be placed in an area so that requirements are met. Site plans to be forwarded to SoH/DoH prior to development approval.
Gradient of the land application area	Where slope exceeds one in five (1:5), the land application area should be engineered to prevent run-off from the land application area. Surface contours should be provided on the site plan.	Yes The natural topography across the Subject Site does not exceed 1:5 grade. Natural and finished gradients of land application areas shall not exceed 1:5 gradient. Site plans to be forwarded to SoH/DoH prior to development approval.
Location of land application area within building envelope	Local government may approve the location of land application areas outside building envelopes where proposed location meets requirements outlined above.	Noted

6. Land Application Areas

In response to the site soil conditions, depth to groundwater and environmental constraints of the site it is recommended that Land Application Areas for onsite effluent disposal be located within the areas deemed as suitable to receive effluent disposal as shown in Figure 11.

The soils at the Subject Site were found to consist predominantly of duplex soils with sand/clayey sand layers of varying depths overlying sandy clay/clays of varying plasticity and permeability. Given the variability of the sand/clayey sand layer depths and the permeability of the sandy clays/clays across the site the most suitable land application systems across the Subject Site may vary. It is recommended that the soil profile be confirmed at a lot scale to ensure the most appropriate land application system is utilised on each lot to prevent failure of the system. There shall be at least 1.2m of free draining soil below the base of the land application system, if there is not an adequate depth of free draining soil, movement of water is restricted and effluent will move away from the disposal field very slowly. In-situ infiltration testing shall be conducted if it is unclear whether or not the soils are free draining with a moderate to high infiltration rate achievable. Where heavy clays with low permeability are present fill or soil modification techniques will be required.

Standard leach drains may be utilised if there is an adequate depth of free draining soil and an adequate depth to the high water-table (1.5m) from the base of the leach drains. In areas dominated by heavy clays or high groundwater (which includes much of the Subject Site) standard leach drains are subjected to failure because the rate of percolation of effluent through the soil is less than the effluent generation rate. In this instance the most suitable system is an irrigation system in conjunction with a secondary treatment system. Irrigation systems operate both by soil absorption and by evapotranspiration from plants and therefore are less susceptible to failure. In addition, irrigation systems generally require less imported fill material to achieve the minimum separation to the high water-table as they are installed much closer to the ground surface.

Typically, secondary treated effluent is applied by one of the following types of irrigation systems:

- Subsurface drip irrigation in which dripper lines are buried in the topsoil at shallow depth;
- Surface drip irrigation in which dosing lines are laid on prepared ground surface and covered in bark or mulch; and
- Spray irrigation system that distributes disinfected effluent (quality as per 5.4.2.5.1 of AS/NZS 1547) over the surface of the ground (AS1547:2012).

Secondary treatment systems are recommended when using irrigation systems due to the shallow nature of the system and the exposure of the effluent to the surface, which may pose a risk to health and the environment.

Irrigation systems shall be designed to ensure that effluent is not applied at rates which exceed the absorption capacity of the soil. Care shall be taken to ensure that the application rate does not lead to:

- Adverse effects on soil properties and plant growth through excess salt accumulation in the root zone during extended dry periods;
- Harmful long-term environmental effects to the soil of the land application system or the adjacent surface water and groundwater; or
- Increased risk to public health from surface ponding in the land application area or channeling or seepage beyond the land application area.

The subsurface irrigation system shall be designed to promote evapotranspiration. Care shall be taken to ensure that the irrigation area is well planted with plant species that are:

- Water tolerant;
- Appropriate for the site conditions; and
- Planted at an appropriate density for effective evapotranspiration.

The size of the land application area required on individual lots based on a single household is shown in Table 4. This has been determined in conjunction with loading rates outlined in Table L1 in AS/NZS 1547:2012.

Table 4: Land application areas for single houses

Soil category	Soil texture	Land Application Area (m^2)	
		Primary treatment (Includes area required for setbacks)	Secondary treatment (Excludes setbacks)
1	Gravels and sands	339	180
2	Sandy loams	339	180
3	Loams	429	225
4	Clay loams	620	257
5	Light clays	1,156	300
6	Medium to heavy clays	Special design	450

The required land application areas (Table 4) are achievable on the proposed lots within the Subject Site with the smallest lot size being 10,000m^2. Upon final placement of the house and permanent infrastructure the new lot owner is to provide all applicable information (e.g., land application area, on-site effluent system etc.) to the Shire of Harvey and Department of Health for approval prior to installation of the onsite effluent disposal system (as shown in Figure 12).

This assessment does not include meeting the objectives of the Code of Practice for On-site Sewerage management with detailed loadings and design capacity of the effluent system to be provided by the owner (to the relevant agencies) at the time of building approval stages.

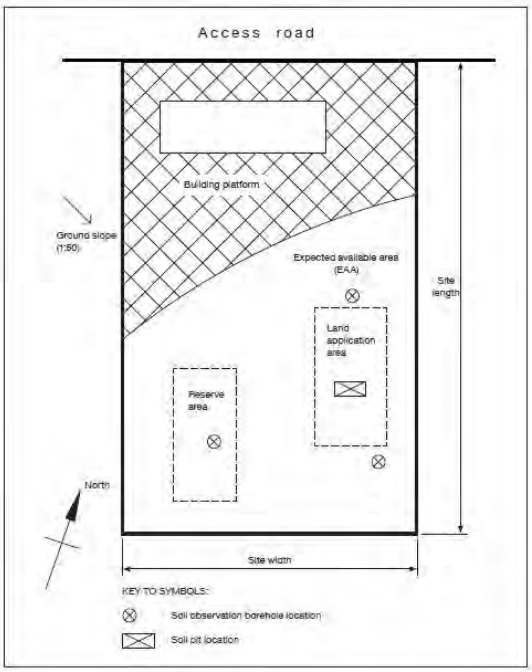

Figure 12: Generalised site plan for a single lot (AS/AZS 1547: 2012)

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Appendix A

Environmental Assessment and Land Capability Assessment (Cardno BSD, 2006)

Cardno BSD

LOTS 121, 246, 314 & 3315 TREENDALE ROAD, ROELANDS

ENVIRONMENTAL ASSESSMENT AND LAND CAPABILITY STUDY

COLLIE RIVER INVESTMENTS PTY LTD

MARCH 2006 JOB NO. V6003

Lots 121, 246, 314 & 3315 Treendale Road, Roelands Environmental Assessment and Land Capability Study

Prepared for: Collie River Investments Pty Ltd

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March 2006

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Cardno BSD Pty Ltd

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1. INTRODUCTION

1.1 BACKGROUND

Lots 121, 246, 314 & 3315 Treendale Road, Roelands (the 'study area') is proposed to be rezoned from "Rural" to "Special Residential" under the Shire of Harvey District Planning Scheme (DPS) No. 1. Given that such changes in land use can have implications for the existing environment, it is generally necessary to undertake an environmental assessment to determine the degree to which significant impacts could arise.

The proposed rezoning of the study area is consistent with existing development of adjacent areas, which have seen the development of similarly sized lots for "Special Residential" purposes.

1.2 SITE DESCRIPTION

The study area is located within the locality of Roelands and Shire of Harvey, approximately 150km south of the Perth Metropolitan area. The location of the study area is shown in **Figure 1**. The study area is situated immediately adjacent to the Collie River, to the east of Australind and is comprised of approximately 124ha of predominantly cleared land. The Collie River borders the study area to the south, east and west, while the northern border of the study area is defined by Treendale Road.

1.3 PURPOSE OF THIS REPORT

Cardno BSD were engaged to investigate the existing environmental conditions and conduct a land capability assessment, both with the aim of determining the suitability of the study area for the proposed use ('Special Residential') and also the capability of the site to support onsite effluent disposal (specifically through the use of Ecomax™ treatment units). This report is intended to document the findings of the above investigations and support both the DPS rezoning and future subdivision of the site.

2. EXISTING ENVIRONMENT

2.1 SOILS AND TOPOGRAPHY

2.1.1 Soils and Landforms

The Swan Coastal Plain is generally flat, approximately 20 – 30kms wide and consists of a series of geomorphic entities running parallel to the coastline. The northern part of the Plain is formed from either fluviatile or aeolian depositional material. The coastal plain itself is low lying, often swampy with Sandhill's and therefore the soils predominately consist of recent sands or swampy deposits (Beard, 1990). The Swan Coastal Plain consists of the Pinjarra Plain and three dune systems (Quindalup, Spearwood and Bassendean) of differing ages of deposition whose soils are at different stages of leaching and formation.

The Landform and Soil units of the surrounding area have previously been mapped by Churchward and McArthur (1978). These maps indicate that the landform and soil types underlying the Fluviatile Deposits of the Swan Coastal Plain Landform and Soil unit, on which the study area is located, are comprised of the "Guildford" and "Swan" soil types. The Guildford soil type is typically represented by flat plains with medium textured deposits comprised of yellow duplex soils. The Guildford soil type corresponds with the gently sloped and cleared pasture areas within the site. The Swan soil type is represented by alluvial terraces with red earths and duplex soils. This soil type corresponds with the alluvial floodplain of the Collie River.

Further guidance as to the soil characteristics and topography of the study area is provided by the *Land Resource Mapping for Harvey to Capel on the Swan Coastal Plain Western Australia* (Barnesby & Proulx-Nixon, 1994). This mapping indicates that the entire site (with the exception of one wetland) is regarded as a part of the Pinjarra Soil-Landscape System. The wetland area is regarded as being a 'Miscellaneous Swamp' and is further described in **Section 2.5.3**.

Within the study area the larger northern portion consists of cleared pasture comprised of flat to very gently undulating plain with acidic mottled yellow duplex soils, comprising moderately deep/shallow pale sand to sandy loam over clay, being imperfectly drained (mapping unit P1b and P1a). This landform includes the steep slopes and valleys that serve as a transition between the undulating cleared pasture and the floodplain of the Collie River. The floodplain (southern) portion of the study area is gently undulating to flat terraces adjacent to the Collie River, but is well below the general level of the plain, with deep well drained uniform brownish sands or loams subject to periodic flooding (mapping unit P10). In addition to the above landforms that underlie the majority of the site, a small circular area is located centrally within Lot 3315 (approximately 2ha) and is a seasonally inundated swamp/depression with very poorly drained variable acidic mottled yellow and gley duplex soils (mapping unit P7).

These soil-landscape mapping units are shown in **Figure 2**, and were confirmed by the site investigations, detailed in **Section 2.1.4**.

2.1.2 Topography

The larger northern portion of the study area varies in height from 18m AHD in proximity to Treendale Road to 4m AHD at the point where it meets the Collie River Floodplain. This results in slopes ranging from 0% to 17%, with a generally southerly aspect. The floodplain of the Collie River varies in width from 20m to 450m and varies in elevation from 0m AHD to 4m AHD. Topographical contours of the study area and major landforms are shown in **Figure 3**.

2.1.3 Site Specific Investigations

In order to provide a measure of on-ground verification of site characteristics that can in turn be used to conduct a land capability assessment (see **Section 4.1**), a number of site-specific parameters were further investigated. These are further discussed in the following sections.

2.1.3.1 Test-pitting

In order to clarify the underlying soil composition on the study area, 14 test-pits were excavated by backhoe to a maximum depth of 3.5m. The location of the test-pits is shown on **Figure 2**. Soil logs of the test-pits can are contained in **Appendix A**. A visual record of the test pit soil profiles is shown in **Plates 1-14**. The composition and profile of the soils was logged and soil samples were taken for analysis. Visual inspection of the soil profile confirmed the predicted soil types, though there was some variability of these across the site.

The soil types underlying the northern portion of the site (test-pits RL1 to RL3, RL5, RL6 and RL9, RL 11 and RL12) were duplex soils, with varying depths (0.2m to 0.7m) of pale quartz sand overlying dense highly plastic clays. The clays were observed to be mottled at depths of 0.7-2.7m throughout this landform, and while these were not observed to be saturated at the time of test-pitting (January 2006), it can be inferred that this mottling is indicative of a perched winter watertable or very low vertical hydraulic conductivity of these portions of the soil profile with the underlying superficial aquifer. Two exceptions to the soil types predicted to underlie the northern portion of the site were found at test pits RL13 and RL14. In these areas the soil profile consisted of red earths to 1.3m overlying hard packed yellow/orange and white/grey clay. Location RL14 was particularly hard-packed and cemented.

Soil types underlying the P7 area were test-pitted (RL4). This area was found to be dense dry clay over cementitious quartz and laterite. The test pit at this location was difficult to excavate and can be considered to be completely impermeable. This was confirmed by the current landowner, who indicated that stormwater runoff does not drain from the area without the assistance of an artificial drainage channel.

Soil types underlying the southern floodplain portion of the site (test pit locations RL7, RL8 and RL10) were found to be red/brown loamy earth of between 1.2m and 2.7m depth, overlying mottled grey/brown, orange/yellow or red/orange clays. These soils are consistent with those that could be expected to be found within alluvial floodplain areas.

Overall the surface soils can be considered to allow moderate infiltration within the surface horizon layer. However, any infiltration of rainfall would be limited by the underlying clay layer, and therefore overall infiltration is likely to be low once the soils are saturated.

2.1.3.2 Soil Analysis

Soil samples were collected from each of the test pits at a depth of 0.2m, in order to capture the characteristics of the different soil types observed. The samples were analysed by a National Association Testing Authority (NATA) accredited laboratory for Bicarbonate Extractable Phosphorous (Bic P), Total Phosphorous (TP) and Phosphorous Retention Index (PRI). This analysis was intended to provide a measure of exchangeable phosphorous, background phosphorous and an indication of the short-term P-retention capacity of the soil (respectively). Samples were not proposed to be analysed for Nitrogen as this is converted rapidly to the nitrate form, which is not adsorbed by soils and is rapidly leached. The results of the soil sample analysis are shown in **Table 2.1.3.2**.

Table 2.1.3.2 Soil Analysis Results

Sample ID	Bic P (mg/Kg)	TP (mg/Kg)	PRI
RL1	41	110	1.8
RL2	16	67	59.7
RL3	8	66	6.5
RL4	21	101	76.2
RL5	-	-	-
RL6	-	-	-
RL7	11	145	115.1
RL8	77	458	159.6
RL9	71	442	36
RL10	14	315	1,427.7
RL11	27	132	55.8
RL12	-	-	-
RL13	103	435	71.2
RL14	174	562	80.7

The laboratory analysis results are also contained in **Appendix B**.

The sample analysis indicates that the nutrient retention capacity of the alluvial floodplain surface soils is very high, while nutrient retention capacity of the surface soils underlying the northern portion of the study area was comparatively low. Nutrient levels within the soils were comparatively high at locations RL8, RL9, RL10, RL13 and RL14, though this is not surprising given that the land is currently used for agriculture. Continued phosphorus application to soils (even those with high PRI) can lead to leaching of phosphorous from soils. However, given the overall high PRI and generally moderate TP of the northern portion of the study area, the soils underlying the northern portion of the study area can be considered to be suited to domestic effluent disposal in terms of nutrient retention ability.

2.1.4 Acid Sulfate Soils

Acid Sulfate Soils (ASS) are naturally occurring soils that contain iron sulphide (iron pyrite) minerals. If disturbed by dewatering, drainage or soil excavation, the pyrites can oxidise thereby release acidity, potentially causing environmental impacts. An overview of the Acid Sulphate Soils (ASS) risk potential on the Swan Coastal Plain is provided in the *Western Australian Planning Commission Planning Bulletin Number 64* (WAPC, 2003). According to the Bulletin, the soils underlying the study area are rated as having a moderate to low risk of actual ASS or potential ASS occurring generally at depths greater than 3m.

2.2 FLORA AND VEGETATION

2.2.1 Background Information

The survey area lies on the Swan Coastal Plain Subregion of the Drummond Botanical Subdistrict within the southwest Botanical Province as described by Beard (1990). Flora composition of the Swan Coastal Plain Subregion has been described by Beard (1990) as predominantly consisting of *Banksia* Low Woodlands on leached sands with *Melaleuca* swamps where ill drained and Woodlands of *Eucalyptus* spp. on less leached soils.

The study area is located on the Fluviatile Deposits of the Swan Coastal Plain landform and Soil Unit. The Fluviatile Deposits underlying the study are comprised of Guildford and Swan Complex vegetation (Heddle *et al*, 1978). The vegetation of the Guildford Complex is typically a mixture of open forest of tall *Eucalyptus wandoo, E. marginata* and *Corymbia calophylla* and woodland of *E. wandoo* (with rare occurrences of *E. lane-poolei*). Minor components include *E. rudis* and *Melaleuca rhaphiophylla.* Heddle *et al.* (1980) describes the vegetation of the Swan Vegetation Complex as predominantly fringing woodlands of *Eucalyptus rudis, Melaleuca rhaphiophylla* with localised occurrences of *Casuarina obesa* and *Melaleuca cuticularis.*

2.2.2 Declared Rare Flora and Priority Listed Flora – Existing Information

Species of flora acquire Declared Rare Flora (DRF) or Priority Flora (PF) conservation status where populations are restricted geographically or threatened by local processes. The Department of Conservation and Land Management (CALM) recognise these threats and subsequently applies regulations towards population protection and species conservation. CALM enforce regulations under the *Wildlife Conservation Act 1950* (WAWC Act) to conserve DRF species and protect significant populations. PF species are potentially rare or threatened and are classified in order of threat.

CALM's Declared Rare and Priority Flora list indicates that a number of species of conservation significance are potentially located in the Bunbury locality, including *Acacia flagelliformis* (P4), *Aponogeton hexatepalus* (P4), *Caladenia speciosa* (P4), *Pultenaea skinneri* (P4), *Rhodanthe pyrethrum* (P3), *Stylidium longitubum* (P3) and *Verticordia attenuata* (P3). However, a search of CALM's *Threatened (Declared Rare) Flora* database indicates that there were no known occurrences of any of the above species within the study area. The results of the CALM database of DRF and Priority Flora search are contained in **Appendix C**.

The Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) promotes the conservation of biodiversity by providing strong protection for plants at a species level. However, none of the species noted above are scheduled under the EPBC Act.

2.2.3 Threatened Ecological Communities

Ecological communities are naturally occurring biological assemblages that occur in a particular type of habitat, are the sum of species within the ecosystem and as a whole provide many of the processes that support specific ecosystems. CALM has been identifying Threatened Ecological Communities

(TECs) for a number of years with the aim of developing and implementing recovery plans for these. While they are not afforded direct statutory protection at a State level (unlike DRF under the WAWC Act) their significance is acknowledged through other State environmental approval processes (i.e. Environmental Impact Assessment pursuant to Part IV of the *Environmental Protection Act 1986*). Scheduled TECs are afforded statutory protection at a Federal level pursuant to the EPBC Act.

A search was undertaken for the study area of CALM's TEC database. The search indicates that there are no known occurrences of TECs recorded within the study area. However, there are occurrences of the 'Critically Endangered' TEC known as '*Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands' and occurrences of the 'Vulnerable' TEC known as 'Herb rich shrublands in clay pans' nearby (within a 5 kilometre radius of the study area). Search results from CALM's TEC database are contained in **Appendix D**.

The Commonwealth EPBC Act promotes the conservation of biodiversity by providing strong protection for TECs. The TEC known as '*Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands' is scheduled under the EPBC Act.

2.2.4 Flora and Vegetation Survey Methods

A botanist from Cardno BSD undertook a Botanical survey on 23rd January 2006. The site was surveyed for flora vegetation communities and condition, Declared Rare Flora (DRF) and Priority Flora and potential areas of TECs. In areas considered to potentially contain TECs, 10 metre by 10 metre quadrats were set up and data recorded to statistically examine the vegetation to determine its likelihood of being considered a TEC. A DRF survey was undertaken by traversing the entire area on foot with transects being parallel and approximately 20m apart.

All plant specimens collected during the flora survey were dried, pressed and then sorted in accordance with the requirements of the Western Australian State Herbarium. Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Nomenclature of species used in this report follows current usage (Western Australia Herbarium 1998-2003).

Aerial photography was used to extrapolate and map plant communities in combination with running notes made during the course of the survey.

2.2.5 Flora and Vegetation Survey Results

2.2.5.1 Recorded Flora

A total of 34 plant taxa, comprising 16 families and 26 genera were recorded in the project area (see **Appendix E**). Species representation was greatest among the Myrtaceae and Papilionaceae families. Three introduced (weed) species were collected. Weeds were abundant in the Poaceae (grasses) and Polygonaceae (Dock) families.

None of the DRF or PF species listed as potentially located on the study area were located during the flora survey. While the survey was not undertaken in Spring (when most of the DRF or PF species would be more likely to be evident), the site has been subjected to continual degrading influences (i.e. stock grazing and trampling) for over 50 years, and it is therefore unlikely that any of the DRF or PF species potentially located in the Bunbury locality would be present.

2.2.5.2 Introduced Species

Eighteen introduced Flora species were recorded on the site. Introduced species (weeds) were recorded in the Poaceae (grass) and Polygonaceae (Dock) families. This represents 53% of the total flora recorded on site.

2.2.5.3 Local Vegetation Communities

Two vegetation communities are represented on the site at a local level. Vegetation Community 1 is the dominant vegetation community within the subject site, and is located on the northern portion of the study area. Community 1 is mostly "Degraded", and remnant native vegetation is represented by large individuals of *Corymbia calophylla, Nuystia floribunda* and *Melaleuca preissiana* with limited understorey. The land in between the tree-lined borders of the northern portion is currently used for grazing and devoid of remnant native vegetation. The pasture areas appear to be covered with introduced weed species associated with pasture or fodder. These weed species have completely replaced the native understorey vegetation over the northern portion of the study area and are common across the Swan Coastal Plain. This vegetation types is best described as Pasture Cleared Marri Woodland. The typical condition of vegetation within this portion of the site is shown in **Plates 15-16**.

Vegetation Community 2 consists of *Eucalyptus rudis* damplands, and this vegetation is mostly in "Good" Condition. This vegetation community is dominant on the southern portion of the study area adjacent to the streamline, and is representative of a transition between the Swan Complex and Guildford Complex, with established *Casuarina obesa, Corymbia calophylla* and *Eucalyptus marginata*, as well as *E. gomphocephala*. Much of the floodplain adjacent to the river has previously been cleared, and is currently used for grazing. The typical condition of Vegetation Community 2 within the southern portion of the study area, and adjacent to the Collie River is shown in **Plates 17-18**.

Vegetation Communities observed onsite are summarised below in **Table 2.2.5.3.**

Table 2.2.5.3: Local Vegetation Communities Recorded at Roelands – January 2006.

Mapping Code	Community Descriptions
Vegetation Community 1 – Pasture cleared Marri woodland	
1	Open woodland of *Eucalyptus marginata, Corymbia calophylla.*
Vegetation Community 2 – *Eucalyptus rudis* damplands	
2	*Open woodlands of Eucalyptus rudis and Casuarina*

2.2.5.4 Regional Vegetation Communities

Species recorded within each vegetation community were compared with species occurring in the Gibson *et al.* (1994) database of vegetation communities on the southern Swan Coastal Plain using the vegetation significance methodology described below. The inferred Floristic Community Type (FCT) is based on the number of species matches and is recorded in **Table 2.2.5.4** below.

Table 2.2.5.4: Inferred Gibson *et al.* Floristic Community Type

Vegetation Community Code	Floristic Community Type
1	3b
2	13

Two Gibson *et al.*, (1994) FCT's have been recorded on site – Vegetation Community 1 is most similar to FCT 3b *Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils. Vegetation Community 2 is most similar to FCT 13 '*Deeper wetlands on heavy soils*'. Vegetation communities found on the study area are shown in **Figure 4**.

FCT 3b is described as *Corymbia calophylla - Eucalyptus marginata* woodlands on sandy clay soils and appears throughout the southern part of the Swan Coastal Plain. FCT 3b has been recorded along the coastal plain from Pinjarra to Busselton and the Gibson *et al.* site descriptions reflect the vegetation occurring on site. FCT 3b is recorded as having a "Vulnerable" conservation category by Gibson *et al.* (1994), and is currently listed as a "Vulnerable" TEC by CALM, however it is not protected under the EPBC Act. The current vegetation predominately consists of over storey with limited understorey species and therefore does not provide a true representation of FCT 3b. This is largely due to historic degradation and grazing of the northern portion of the study area.

FCT 13 is described as 'Deeper wetlands on heavy soils' and appears throughout the southern part of the Swan Coastal Plain. FCT 13 has been recorded along the coastal plain from Pinjarra to Busselton and the Gibson *et al.* site descriptions reflect the vegetation occurring on the southern portion of the study area. FCT site 13 is well-reserved community type in a low risk category in accordance to its conservation status (Gibson *et al* 1994).

2.2.5.5 Vegetation Condition

The Vegetation Condition was rated according to the Vegetation Condition Scale commonly used in the Perth Metropolitan Region (Government of WA, 2000). In general, the vegetation condition ranged from "Very Degraded" to "Good". The majority of the area has been parkland cleared and therefore retained little to no structure and native species. Areas of "Good" vegetation occur within Vegetation Community 2, along foreshore areas of the river. Vegetation condition mapping has been prepared based on field observations made during the flora survey and with current aerial photography and is shown in **Figure 5**.

2.3 ENVIRONMENTALLY SENSITIVE AREAS

Environmentally Sensitive Areas (ESAs) are areas that cannot be cleared under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. These have been identified in order to protect the native vegetation values of areas surrounding significant, threatened or scheduled ecosystems or communities. The DOE's database of ESAs (DOE, 2006) indicates that the study area includes all or portions of three ESAs. These ESAs are consistent with the locations (or portions thereof) of wetland #1733 (including a 50m buffer), and the 1992 EPP boundaries of wetland #1869, and the 'sumpland' within wetland #1736 (see **Section 2.5** for wetland descriptions). ESAs within the study area are shown in **Figure 6**.

2.4 HYDROLOGY

2.4.1 Groundwater

Predicted groundwater levels were not available for the study area from the Perth Groundwater Atlas, however the Department of Environment (DOE) provided records from monitoring bores and nearby private bores. One of the monitoring bores (AWRC ref HS73A) was located within Lot 3315. The elevation of the DOE monitoring bore is approximately 16m AHD, and its location is shown in **Figure 3**. Records for the previous 18 years were available for this location. The records indicate that the water table varies in elevation from 7.7m AHD to 9.8m AHD. Given that the base of the streamline located on the southern border of the site has an elevation of between 0-2m AHD, and that there are no significant areas of groundwater discharge or recharge between the Collie River/adjacent wetlands and the bore site, it can be inferred that the groundwater levels between these locations slope from 10m AHD to 0-2m AHD with the hydraulic gradient running in an north-south orientation towards the Collie River/adjacent wetlands. This would indicate a minimum depth to groundwater underlying the northern portion of the study area of approximately 6m.

A number of test-pits were excavated on the study area to a depth of 2-4 metres to observe the soil profile, collect soil samples and observe the soil moisture content (see **Section 2.1.4**). While the soils at some locations were observed to be slightly moist the watertable was not encountered, suggesting that the depth to water is greater than three metres. However, the presence of mottled grey clay soils at varying depths (0.7-2.7m) across the study area suggests that localised winter groundwater levels may be perched above the low permeability clay layers.

2.4.2 Surface Water

As indicated previously, the study area is bordered by the Collie River and Collie River floodplain. Anecdotal evidence provided by the current landowner (who has owned the site for approximately 50 years) indicates that the floodplain becomes inundated every 10-12 years, usually in years when the Wellington Dam overflows. The extent of the Collie River floodplain in the vicinity of the study area is denoted within the *Swan Coastal Plains Geomorphic Wetlands* dataset as wetland #1736. The extent of the floodplain based upon this data is shown in **Figure 6**. Further data was provided by the Water Corporation regarding historical maximum flood levels within the Collie River in the vicinity of the study area, at the confluence of with Henty Brook. This data indicates that the maximum recorded flood level at this location was approximately 5mAHD. This level has been used to determine the approximate extent of the Collie River floodplain within the study area. The previously recorded floodplain of the Collie River is generally consistent with the data provided by the Water Corporation, with the exception of the hill located on the northeastern corner of Lot 314. The hill on the northeastern corner of Lot 314 has an elevation of up to 10m AHD, and is unlikely to be inundated given that the historical maximum recorded level of the Collie River in proximity to the study area is 5m AHD.

There are three wetlands located within the study area that support permanent water, and these are described in in further detail in the following Section.

2.4.3 Wetlands

Wetlands on the Swan Coastal Plain have previously been previously been classified by the former Water and Rivers Commission (WRC) and detailed within the Swan Coastal Plains Geomorphic Wetlands dataset. The Swan Coastal Plain Geomorphic wetlands dataset indicates that the entire study area is classified as a group of wetlands or part thereof. The details of the wetlands, as provided within the dataset are as follows:

- A portion of a large (10,150ha) 'palusplain' Multiple Use Wetland (MUW) (wetland ID # 13240);
- A portion of a 347ha 'floodplain' that has been evaluated as MUW (wetland ID #1736);
- A 5.9ha 'sumpland' that has been evaluated as Resource Enhancement Wetland (REW) (wetland ID #1869);
- A 2.8ha 'sumpland' that has been evaluated as MUW (wetland ID #1718);
- A portion of a 8.6ha 'floodplain' that has previously been evaluated as Conservation Category Wetland (CCW) (wetland ID #1733).

These wetlands are shown in **Figure 6** and are further described in the following sections.

2.4.3.1 Wetland #13240

The majority of the study area, comprised predominantly of the northern undulating plain, is a part of a large 'palusplain' MUW. This area varies in elevation from 18mAHD to approximately 4m AHD where it borders the Collie River floodplain. While this area is classified as a wetland, the underlying landforms are undulating plains, predominantly at an elevation of approximately 16mAHD.

Furthermore, it does not retain any attributes of a wetland and does not support any wetland dependant vegetation. It is therefore considered that the classification of this area being a wetland is not consistent with the observed characteristics of this portion of the study area. The typical condition of the northern portion of the study area is shown in **Plates 15** and **16**.

2.4.3.2 Wetland #1736

The floodplain of the Collie River within the study area is a part of a 347ha 'floodplain' that has been evaluated as MUW. This area has been mostly cleared for grazing, and remnant vegetation is limited to a thin strip of riparian vegetation along the Collie River. The typical condition of the 'floodplain' is shown in **Plates 17** and **18**. The entire floodplain area was observed to be currently utilised for grazing. Given the degraded condition of the floodplain area, it is considered that the MUW management category is appropriate. There is another approximately 3ha area located within the Collie River floodplain, that was not specifically identified within the Geomorphic Wetlands dataset, and this area appears to be have characteristics consistent with a 'sumpland' wetland. This 'sumpland' wetland area is completely devoid of overstorey species, and has limited sedges and rushes that appear to have been impacted by stock grazing and trampling. The wetland does not retain any native vegetation buffer. The typical condition of the 'sumpland' is shown in **Plate 19**.

The 'sumpland' wetland area is included within the EPA's *Environmental Protection (Swan Coastal Plain Lakes) Policy* (EPP) *1992* (EPA, 1992), and as such is afforded statutory protection from various acts or activities. However close inspection of the boundaries of the wetland as included within the 1992 EPP reveal that the boundaries do not coincide with the on-ground location of the wetland. Given that the positional accuracy of the 1992 dataset is +/- 100m it can safely be assumed that the mapping resolution utilised for creation of the 1992 dataset does not accurately depict the wetland's location. This is confirmed by inspection of the *Revised Draft Environmental Protection Policy (Swan Coastal Plain Wetlands) Policy 2004* (EPA, 2004), in which the location of the revised wetland boundaries is approximately 100m to the south of the 1992 EPP boundaries.

2.4.3.3 Wetland # 1869

Within the floodplain area a 5.9ha 'sumpland' is located immediately adjacent to the Collie River floodplain (though it is effectively a part of the floodplain) that has been evaluated as REW. This wetland is also known as 'Shag Swamp', and has a dense overstorey and relatively intact understorey, though the edges of the wetland appear to have been degraded by stock grazing and weed infestations. The condition of this wetland is shown in **Plate 20**. Given the density of overstorey vegetation, though reduced understorey, it is considered that the currently assigned management category is appropriate.

Wetland #1869 is also protected under the 1992 EPP, however similar spatial boundary issues exist to those detailed for wetland #1736. Close inspection of the boundaries of wetland #1869 as included within the 1992 EPP reveal that the boundaries do not coincide with the on-ground location of wetland #1869. Given that the positional accuracy of the 1992 dataset is +/- 100m it can safely be assumed that the mapping resolution utilised for creation of the 1992 dataset does not accurately depict wetland

#1869's location. This is confirmed by inspection of the *Revised Draft Environmental Protection Policy (Swan Coastal Plain Wetlands) Policy 2004* (EPA, 2004), in which the location of wetland #1869 boundaries are approximately 100m to the south of the 1992 EPP boundaries.

2.4.3.4 Wetland # 1718

A further 'sumpland' is immediately adjacent to (though effectively encompassed by) the floodplain, being a 2.8ha MUW. This wetland is completely devoid of overstorey species, and vegetation is limited to degraded sedges and rushes. The sedges and rushes appear to have been degraded due to the influence of stock grazing and trampling. The wetland does not retain any surrounding vegetative buffer. The condition of this wetland is shown in **Plate 21**. Given the degraded condition of the floodplain area, it is considered that the MUW management category is appropriate.

2.4.3.5 Wetland # 1733

Immediately adjacent to Wetland #1718 is a 7.8ha CCW that is recorded as being 'floodplain'. The majority of the CCW does not fall within the study area, however a small portion (0.3ha) lies within the boundary of Lot 121. The portion of the CCW that does lie within Lot 121 consists of a few isolated overstorey species, and does not appear to support any native understorey. The CCW and a 50m buffer are recorded as being an ESA (DOE, 2006). The majority of the CCW was not assessed during this study, and therefore no evaluation is made as to how appropriate the current management category is.

2.5 THREATENED FAUNA AND FAUNA HABITAT

CALM's Threatened Species List contains two species that could potentially occur on the study area, namely the Western Ringtail Possum (*Pseudocheirus occidentalis*) and the Peregrine Falcon (*Falco peregrinus*). The Western Ringtail Possum is known to occur in areas of *Agonis flexuosa* woodland and requires tree hollows and/or dense canopy for refuge and nesting. As the majority of the site has been cleared, and remnant vegetation across the majority of the site is limited to large established trees along pasture borders, it is unlikely that this species would be present on the site. The Peregrine Falcon is uncommon, and prefers areas with rocky edges, cliffs, watercourse, open woodland or margins with cleared land. It is therefore possible that this species could be an occasional visitor to the study area. Search results of the CALM Threatened Fauna database are contained in **Appendix F**.

The general fauna habitat value of the southern (floodplain) portion of the study area that contains the Collie River and adjacent floodplain could be considered to be moderate. This is due to the presence of some individuals of *Agonis flexuosa* along the shoreline of the Collie River, although there were only several individuals of this species noted. The habitat value of the remainder of the floodplain area is higher than would be expected for an area subjected to the extent of historical clearing and subsequent grazing of the study area. This is due to the presence of Wetland #1869 being located on the floodplain. The core of Wetland #1869 is largely undisturbed, a dense cover of understorey species and retains some dryland buffer with a number of mature trees, and could therefore potentially provide habitat for a number of species. Vegetation within Wetland #1718 consists of sedges and

rushes, while vegetation within the small portion of the CCW within Lot 121 is limited to a few mature trees.

Fauna habitat values associated with the northern portion of the study area have been severely reduced by the historic clearing of native vegetation. The few remaining larger trees in this portion of the study area are within a degraded habitat, being predominantly situated on the property and access road borders. It is therefore unlikely that habitat for any of the above species will be affected by its development.

It is not considered that the northern portion of the study area would provide a significant wildlife corridor function, as it is a largely cleared site, located amongst similarly cleared grazing land with no significant areas of remnant vegetation nearby. However, the riparian vegetation fringing the Collie River and wetland #1869 are likely to provide some corridor/drought refuge functions, and impacts to these areas should be avoided.

2.6 ETHNOGRAPHIC CONSIDERATIONS

2.6.1 Aboriginal Heritage

A search of the Department of Indigenous Affairs (DIA) database of known sites of aboriginal significance (DIA, 2006) indicates that there are no known sites of significance within the study area.

2.6.2 European Heritage

A search of the Heritage Council of Western Australia's database (Heritage Council of WA, 2006) found that no recorded sites of European heritage occur within the study area. The Shire of Harvey's Municipal Heritage Inventory does not list any sites of significance within the study area (Shire of Harvey, 1996).

2.7 HISTORIC AND SURROUNDING LAND USES

2.7.1 Study Area Land Use

The current observed use of the study area is stock grazing of dairy cattle. Anecdotal evidence indicates that stock grazing has been the land use for the at least the last 50 years (*pers comm.* Kevin Moore). Grazing is not an activity that is likely to cause significant soil and/or groundwater contamination of the study area.

There are 132Kv and 66Kv powerlines and associated 32m and 25m easements dissecting the site (see **Figure 7**).

2.7.2 Surrounding Land Uses

The current use of immediately adjacent properties (i.e. north of Treendale Road) was observed to be stock grazing of dairy cattle. Other surrounding land has been developed for 'Special Rural' purposes

(to the east) and for 'Special Residential' purposes (to the west) (Shire of Harvey, 1996). Other land in the general vicinity of the study area (i.e. south of the Collie River and floodplain) is predominantly used for stock grazing, however a minor amount of viticultural use was observed approximately 150m south of the Collie River.

2.8 SUMMARY OF EXISTING ENVIRONMENT

In summary, the investigation into environmental considerations indicates that:

- The study area is composed of two widely differing landforms, being the previously cleared undulating and 'scarp' northern portion and the Collie River Floodplain adjacent to the Collie River;
- Soils underlying the study area are sandy clays with a thin surface horizon of quartz sand of varying depth. Surface soils can be expected to provide reasonable permeability, while subsoils can be expected to generally have a low permeability;
- Onsite investigations indicate that:
    - soils on the northern portion of the site are duplex quartz sand (0.2-0.7m) over dense highly plastic clays. Clays were mottled at depths of 0.7-2.7m, suggesting a seasonal perched watertable at this depth;
    - Soil types underlying the southern floodplain portion of the site were found to be red/brown loamy earth of between 1.2m and 2.7m depth, overlying mottled grey/brown, orange/yellow or red/orange clays. These soils are consistent with those that could be expected to be found within alluvial floodplain areas.
- Soil analysis indicates that the surface soils underlying the northern portion of the study are have a low to moderate nutrient retention capacity;
- Flora values of the northern portion of the study area are minimal, as this area has been cleared and used for pasture. The native vegetation adjacent to the streamline appeared to be in good condition, though understorey species were scarce;
- The Collie River borders the study area to the south and the adjacent Collie River floodplain within the study area contains substantial riparian vegetation;
- A search of CALM's database of DRF and Priority flora indicated that there are no known records for any of these species on the study area;
- A search of CALM's TEC database indicated that there are no known TEC occurrences within the study area;
- Based on DOE information, three ESAs are located within the study area, the locations of which are consistent with a 50m buffer from wetland #1733, the 1992 EPP boundaries of wetland #1869, and the 1992 EPP boundaries of the 'sumpland' that is a part of wetland #1736;
- All available information consulted indicates that the groundwater underlying the northern portion of the study area is at considerable depth (>8m) and that infiltration to groundwater is likely to be very slow to non-existent due to the highly impermeable clays in the soil profile;
- The entire site is classified as mostly wetland under the DOE's Swan Coastal Plain Geomorphic Wetlands dataset. The northern 'palusplain' MUW portion (ID #13240) covers the majority of the site, however it does not exhibit any qualities consistent with the definition of "wetland". The floodplain of the Collie River has been determined to be MUW (ID

#1736). Within the practical extent of the Collie River floodplain there are four wetlands or portions thereof, being a 5.9ha REW that is recorded as being a 'sumpland' (ID #1869), a 2.8ha MUW that is also recorded as being a 'sumpland' (ID #1718), a 0.3ha portion of a larger CCW (mostly situated beyond the boundary of the study area) (ID #1733) and a sumpland that is recorded as being a part of wetland #1736. Two of these wetland areas are protected by the 1992 EPP, though the positional accuracy of the 1992 EPP boundaries may require re-evaluation prior to undertaking ground disturbing activities to verify that the on-ground boundaries (and as recorded in the Revised Draft 2004 EPP) are considered to be accurate;

- A search of CALM's database of database of Threatened Fauna indicated that there are no known occurrences of Threatened Fauna within the study area;
- A search of the DIA database of known sites of aboriginal significance (DIA, 2006) indicates that there are no known sites of significance within the study area;
- A search of the Heritage Council of Western Australia's database (Heritage Council of WA, 2006) found that no recorded sites of European heritage occur within the study area; and
- The site has been historically cleared and has been utilised for the purposes of grazing for over 50 years.

3. PROPOSED FUTURE DEVELOPMENT

The study area is proposed to be re-zoned from '"Rural" to "Special Residential" under the Shire of Harvey District Planning Scheme (DPS) No. 1. The rezoning will include an Outline Development Plan that will further detail the manner in which the site will be developed. Once re-zoned, it is envisaged that the study area will be sub-divided into minimum 2000m^2 parcels. Cardno BSD recommends that the lots should be located predominantly within the northern undulating plain portion of the study area, and that building envelopes are specified such that development does not encroach on any ESAs, floodplain areas or recommended foreshore reserves.

The development will involve the installation of a number of sealed roads, as well as services including reticulated water and power. The development will not be connected to reticulated sewer and will therefore utilise onsite effluent disposal methods (i.e. septic tank and/or Ecomax^{TM} treatment units).

4. ENVIRONMENTAL IMPACTS AND MANAGEMENT

The potential environmental impacts relating to the issues identified within the existing environment are discussed in the following sections.

4.1 LAND CAPABILITY ASSESSMENT

The proposed development will involve the utilisation of onsite disposal of household effluent. Given the proximity of the development to the Collie River, and two EPP wetlands, there is the potential for soluble nutrients to end up impacting on these receiving environments. The extent of the potential for nutrients from effluent disposal to impact these downstream environments is largely a function of the

capability of the land to provide an effluent treatment function and the extent of treatment that will be provided to the effluent by the proposed disposal system.

Land capability refers to the ability of land to support a type of land use without causing damage (Austin & Cocks, 1978). It thus considers both the specific requirements of the land use, plus the risks of degradation associated with the land use. As a general guide for conducting land capability assessments, the evaluation should be carried out based on all available information (van Gool & Moore, 1999). The assessment can be conducted based upon published land resource mapping, however attributed land qualities should be checked against field observations. In this instance, site specific aspects investigated include:

- Test-pitting to determine soil profiles;
- Laboratory analysis of soil samples;
- Visual observation of presence/absence of groundwater in test-pits;
- Research of records from underlying and/or nearby groundwater bores; and
- Anecdotal evidence from surrounding residents and landowners.

4.1.1 Assessment of Land Qualities

The process for conducting a land capability assessment is to first assess the relevant land qualities. It is understood that the building envelopes would not be located within the floodplain area, immediately adjacent to the streamline or within the seasonally inundated swamp (mapping unit P7 and test pit location RL4). Therefore the assessment of land qualities has been limited to the larger, gently sloped northern portion of the study area.

The land capability assessment for septic tanks for rural residential development is intended to cover areas that can be used for soil absorption and purification of septic tank effluent. It is understood that the proposed development will utilise Ecomax™ treatment units, rather than traditional septic tank effluent disposal systems. The treatment requirements for septic tank effluent disposal systems are substantially more extensive than is required for Ecomax™ treatment units, therefore the land capability assessment can be considered to be a conservative assessment.

The land qualities important to onsite effluent disposal within developments include:

- Waterlogging;
- Microbial purification ability;
- Land instability;
- Ease of excavation; and
- Flood risk.

The assessment of each of these qualities results in a rating being assigned to each land quality of 'nil' (N), 'very low' (VL), 'low' (L), 'moderate' (M) or 'high' (H) and is further detailed below.

4.1.1.1 Waterlogging

Waterlogging is excessive water in the root zone accompanied by anaerobic conditions. The excess water inhibits gas exchange with the atmosphere and biological activity uses the available oxygen and photosynthesis is impaired. Field inspections were carried out in January, and while the underlying clay soils were observed to be moist, they did not appear to be saturated. While the majority of the northern portion of the study area is not subject to inundation, it appears that it may have a seasonally perched watertable at a depth of 0.7-2.7m based upon the depth of mottled clays within the soil profile. According to the current landowner, some parts of the northern portion of the study area remain green longer than others (*pers. comm.* Kevin Moore), further suggesting the presence of a perched watertable in some areas.

Given that the test pitting was undertaken in January 2006, and that groundwater levels generally peak around October-November each year, it can be assumed that the groundwater level observed is 2-3 months beyond the seasonal peak. The groundwater underlying the northern portion of the site is therefore likely to be perched for less than 4-6 months per year. Therefore, the majority of the northern portion of the site can be considered to have a 'high' to 'moderate' waterlogging rating.

4.1.1.2 Microbial Purification Ability

Microbial purification relates to the ability of the soil used for septic effluent disposal to remove microorganisms that may be detrimental to public health. It is essentially a measure of the permeability and aeration within the soil profile, which influences its ability to remove undesirable micro-organisms from septic effluent and provide suitable conditions for the oxidation of some organic and inorganic compounds added to the soil as effluent.

The northern portion of the study area surface soil properties consist of medium to fine grained coloured quartz sands and have a depth to the poorly structured clay layer of 0.4m to 0.7m. Therefore, the study area can be considered to have a 'very low' microbial purification rating.

4.1.1.3 Land Instability

Land instability assesses the potential for rapid movement of a large volume of soil. This includes mass soil movement through slope failure, shifting sand dunes, wave erosion and subsidence in karst topography (land underlain by caves). Factors that need to be considered include the slope of land, presence of through-flow, geological features such as attitude of bedding planes relative to slope, rock fracture and shear zones, topographic features such as proximity to cliff or scarp faces and climatic features such as the susceptibility to groundwater saturation.

The northern portion of the study area has a slope of between 0% and 27% (maximum of approximately 17%) and would shed water readily and given that significant seepage or through flow is unlikely due to the underlying clay soils, this portion of the site can therefore be considered to have a 'very low' land stability hazard.

4.1.1.4 Ease of Excavation

The ease of excavation refers to the ease with which soil can be excavated for building construction or earthworks, commonly at depths ranging from 0.3m to 1.5m. These earthworks relate to activities such as levelling of building sites, installation of septic tanks and leach drains and shallow excavations for building foundations.

As the depth to rock is greater than 1.5m, the maximum slope is approximately 17%, there is <20% stone (laterite gravels) within the soil profile, no rock outcrops and a 'high' waterlogging risk, the study area is considered to have a 'moderate' ease of excavation.

4.1.1.5 Flood Risk

Flooding is the temporary covering of land by moving water from overflowing streams and runoff from adjacent slopes. As the northern portion of the study area is elevated and can be considered to have a 'nil' flood frequency return interval, the study area can be considered to have a 'nil' flood risk rating.

4.1.2 Land Capability Assessment

The land capability assessment has been conducted consistent with the guidelines for assessing land qualities and determining land capability in south-west WA produced by the Agriculture Department of WA (AGWA) and detailed in the document *Land Evaluation Standards for Land Resource Mapping* (van Gool & Moore, 1999). Key inputs for the capability assessment are the published *Land Resource Mapping for Harvey to Capel on the Swan Coastal Plain Western Australia* (Barnesby & Proulx-Nixon, 1994) and the site characteristics determined through site inspection, soil test pitting and soil analysis.

Once the land qualities have been assessed, these can be compared against the AGWA produced land capability tables (van Gool & Moore, 1999). These tables allow a standard assessment to be carried out based upon interpretation of land capability resource mapping and site-specific investigations. The land capability table for septic tanks for rural residential development is shown in **Table 4.1.2.1**, with land qualities (as determined above) being shown shaded.

Table 4.1.2.1 Land Capability for Septic Tanks for Rural Residential Developments (van Gool & Moore, 1999).

Land Quality	Land Capability Class				
	1	2	3	4	5
Water logging	N, L, VL		M	H	VH
Microbial Purification	H	M	L	VL	
Land Instability	N	VL	L	M	H
Ease of Excavation	H	M	L	VL	
Flood Risk	N		L	M	H

The land capability class is then determined by the most limiting land quality. The five capability classes commonly utilised are shown in **Table 4.1.2.2** (adapted from Wells & King, 1989).

As indicated previously, it is highly recommended that the building envelopes are not located within the steeply sloped easternmost portion of the study area (immediately adjacent to the streamline) due to the environmental (see **Section 2**) and policy (see **Section 4.1.4**) constraints associated with this portion of the lot. Therefore the assessment of land qualities and subsequent land capability assessment has been limited to the larger, gently sloped western portion of the study area.

Table 4.1.2.2 Land capability classes for given land-use types.

Capability Class	General Description
1- Very high	Very few physical limitations present and easily overcome. Risk of land degradation is negligible.
2 – High	Minor physical limitations affecting either productive land use and/or risk of degradation. Limitations overcome by careful planning.
3 – Fair	Moderate physical limitations significantly affecting productive land use and/or risk of degradation. Careful planning and conservation measures required.
4 - Low	High degree of physical limitation not easily overcome by standard development techniques and/or resulting in high risk of degradation. Extensive conservation measures required.
5 – Very low	Severe limitations. Use is usually prohibitive in terms of development costs or the associated risk of degradation.

In this case the land capability for septic tanks for rural residential development of Lots 121, 246, 314 & 3315 Treendale Road, Roelands is limited by the 'very low' microbial purification ability, and 'high' waterlogging risk, giving a land capability class of '4'. A land capability class of '4 - low' indicates that the study area has a high degree of physical limitation not easily overcome by standard development techniques and/or development could result in high risk of degradation. In the case of sites that have a low land capability, extensive conservation measures may be required in order for the development to proceed. On this basis it is recommended that septic tanks are not proposed for effluent disposal. It is recommended that Ecomax™ treatment units that utilise inverted installation leach drains be utilised to address low microbial purification ability and high waterlogging risk.

Given that Ecomax™ units are proposed to be utilised for effluent disposal, the study area can be considered to have a '2 - high' capability for residential subdivision, with the limiting factors being a 'moderate' ease of excavation and 'very low' land instability. A land capability class of '2' indicates that there are only minor physical limitations that can be overcome by careful planning. The inverted installation of Ecomax™ units is further detailed below.

Given the highly impermeable soils under the northern portion of the study area (the area that would most likely be developed), and the high nutrient retention ability of the clay soils (see **Section 2.1**) it is unlikely that the Collie River will be impacted by migration of nutrients through groundwater. As the soils are highly impermeable, soluble nutrients would be more likely to be mobilised by surface runoff than percolate to groundwater.

4.1.3 Ecomax Effluent Treatment Units

Ecomax ™ treatment units are an alternative treatment effluent system that utilises two cells used in rotation. A large part of the treatment process occurs during the effluent flow through the cell and subsequently through the amended soil medium within which the leach drains are installed. The treatments that are applied to effluent water through the Ecomax™ system include a number of treatment processes during the flow through cell, including filtration, pH adjustment, ion exchange, specific adsorption, precipitation, nitrification/denitrification, detention and evaporation or dilution.

The system can be utilised in areas of high groundwater and/or impermeable soils through an 'inverted installation'. An inverted installation involves the use of an impermeable liner and amended sand medium underlying and surrounding the leach drains. In these instances the maximum elevation above ground level is 600mm, though this can be reduced where localised soil conditions permit.

Ecomax™ units have been granted approval for their installation in high groundwater and/or impermeable soil conditions from the Health Department of Western Australia. The approval from the Health Department of Western Australia is shown in **Appendix G**. Given that Ecomax ™ units have been approved by the Health Department of Western Australia, and that when installed using an 'inverted installation' they will address the two issues of concern identified in the land capability assessment (microbial purification ability and waterlogging risk), it can safely be said that the use of these units would be appropriate for the proposed development.

4.1.4 Effluent Disposal Policy

Guidance on the use of on-site effluent disposal methods for Residential developments is provided from a number of government agencies, including:

- The Health Department of Western Australia;
- The Shire of Harvey; and
- The Environmental Protection Authority.

4.1.4.1 Health Department of WA

The Health Department of Western Australia has responsibilities under the *Health Act 1911* to approve on-site effluent disposal system types and provide advice generally on on-site effluent disposal systems. As indicated above, the Health Department of Western Australia has approved Ecomax™ treatment units for high watertable and/or impermeable soil conditions. Indicative guidelines for lot sizes and setbacks to protect the environment are in the *Draft Country Sewerage Policy* (Health Department of Western Australia *et al*, 1999). The Policy provides guidance to statutory authorities, local government and the development industry about sewerage requirements at subdivision and development stages.

The Policy indicates that proposals for large lot subdivision or density development can be considered if they do not involve creation of lots less than 2000m^2, provided that the statutory authority is satisfied that there is no opportunity within the area covered by the proposal for further subdivision without sewerage. Proposed lot sizes range from just over 2000m^2 to over 7000m^2.

Other requirements detailed in the Policy that apply as a minimum in all locations include:

- The wastewater disposal site should not be subject to inundation or flooding at a probability greater than once in 10 years;
- No wastewater system shall be constructed so that effluent or liquid wastes will be discharged into the ground at a distance less than 30 metres from any well, stream or private water supplies intended for consumption by humans;
- No wastewater system shall be constructed so effluent or liquid waste is discharged into the ground within 6 metres of any subsoil drainage system or open drainage channel; and
- Setbacks, groundwater clearance and installation requirements of systems other than conventional septic tank systems shall comply with any particular requirement relevant to the particular system.

4.1.4.2 Shire of Harvey

Domestic wastewater systems are controlled under the *Health Act 1911* and *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974*. The Shire of Harvey administers application and issue of approval to install domestic wastewater systems within the Shire. Communication with the Shire has confirmed that while the Shire has no specific published policy relating to minimum lot sizes and foreshore setbacks, the District Planning Scheme (DPS) No.1, specifies that current minimum lot sizes within 'Special Residential' areas should be no less than 4000m^2 (*pers comm.* Jake Davidson). However, the Shire of Harvey's Draft Local Planning Strategy indicates that future developments within 'Special Residential' areas may be allowed from 2000m^2. Therefore, and amendment to the DPS would need to be sought to facilitate the proposed development of the study area.

4.1.4.3 Environmental Protection Authority

The Environmental Protection Authority (EPA) has published guidelines for on-site effluent disposal. These are documented in *Guidance Statement No.33 Environmental Guidance for Planning and Development* (EPA, 2005).

The document states that:
"On-site effluent disposal is considered to be a practical option for new development areas only where residential densities or the number of systems will remain low, and connection to reticulated sewerage is not feasible."

The Guidance Statement recommends that the environmental requirements in the *Draft Country Sewerage Policy* (see **Section 4.1.4.1**) are taken into account, and that sufficient site-specific studies are carried out early in the planning process to demonstrate that the development will be carried out in a way that is consistent with the environmental objectives and criteria for the receiving environment. It is considered that the second recommendation has been addressed by the information provided in this report.

The Guidance Statement recommends that management measures to ensure that acceptable environmental outcomes occur take into account:

- The density of development and minimum lot sizes;
- The specific location of building envelopes;
- Setbacks for onsite effluent disposal systems/building envelopes from environmentally sensitive areas; and
- Other requirements to ensure on-site systems achieve the desired environmental objectives.

Further setback requirements are applicable for developments within Public Drinking Water Source Areas and ESAs, and as indicated in **Section 2.3** there are portions of the study area that are recorded as being ESAs.

4.2 ACID SULFATE SOILS

As indicated in **Section 2.1.3**, the soils underlying the study area have been rated as having a moderate to low risk of actual ASS or potential ASS at depths of greater than 3m. As excavations on the site are likely to be limited to shallow services (e.g. power and water), road sub-base and low density housing footings, it is not anticipated that there will be significant potential to disturb ASS. Therefore no specific management measures are proposed to address ASS risk.

4.3 FLORA AND VEGETATION

Site specific investigations indicate that the majority of the site is in a 'Very Degraded' condition. In order to prevent further degradation of the flora values of the site it is recommended that the remnant vegetation (i.e. isolated mature paddock trees) within these areas be retained wherever possible.

As there is little remnant vegetation remaining on the northern portion of the study area, and what does remain has become degraded, it is unlikely that any DRF or Priority Flora are present in this portion of the study area.

The vegetation located along the shoreline of the Collie River, and within wetland #1869 was assessed to be in a 'Good' condition. In order to provide protection for the riparian vegetation, it is recommended that the vegetation within these areas should be protected within a 30m wide Foreshore setback. It is recommended that areas that are indicated as foreshore setbacks, EPP wetlands or ESAs are encompassed within a Foreshore Reserve, and that these areas are not included within lot boundaries, and will either be reserved for Public Open Space (POS) or conservation reserves. Provided the recommended Foreshore Reserve is adopted, it is not anticipated that there will be any significant impacts to the flora values of the study area.

None of the DRF or PF species listed as potentially located on the study area were located during the flora survey, however it should be noted that at least two of the Priority species listed as potentially occurring within the study area (*Rhodanthe pyrethrum* (P3) and *Stylidium longitubum* (P3)) October to December flowering annuals that prefer clay pan areas, and are therefore unlikely to be observed during January. It is therefore recommended that a comprehensive flora survey be conducted in late

spring to ensure that none of the DRF or Priority species potentially occurring on the site are present prior to commencement of site clearing.

While the development concept plan is at this stage not finalised, it is anticipated that some of the floodplain area may be included within lot boundaries. It is recommended that building envelopes should not be located within the low-lying (floodplain) portions of the study area in order to maintain the flood conveyance functions of the floodplain and to protect private infrastructure.

Given that building envelopes would not be located within the Collie River floodplain, and that remnant vegetation within the northern portion of the site will be retained wherever possible, it is not anticipated that there will be any significant impacts to the flora values of the study area. It is recommended that the streamline and wetland areas should undergo some form of restoration works to improve their value as POS and conservation reserves, and therefore the flora values of the study area are likely to be enhanced, rather than impacted, as a part of the proposed development.

4.3.1 Collie River Foreshore Management

The Western Australian Planning Commission (WAPC) *Development Control Policy 2.3 Public Open Space in Residential Areas* indicates that a development setback of 30m from waterways is generally required. The EPA also provides guidance with regard to Foreshore Reserves in *Guidance Statement No.33 Environmental Guidance for Planning and Development* (EPA, 2005). The Guidance Statement refers to the document *Determining Foreshore Reserves* (WRC 2001), which recommends an assessment of biophysical features of a waterway to determine an adequate foreshore reserve. The biophysical factors that should be considered include vegetation, hydrology, soil type, erosion, geology, topography, function, habitat, climate, land use and heritage.

By definition, the extent of the waterway includes the floodplain, and therefore any foreshore reserve would normally be determined from the boundary of the 100 year floodplain. The floodplain is 10-300m wide, and the upper boundaries are defined by steep slopes where it adjoins the northern undulating plain (at an approximate elevation of 5mAHD). However, the vegetation structure of the floodplain has historically been substantially changed (through clearing) and the hydrological regimes have also been altered (through upstream damming of the Collie River) to the point where the floodplain now serves an occasional flood conveyance function, but supports negligible riparian and wetland vegetation values.

The location of two EPP wetlands along the northern extremity of the floodplain and a minor portion of a CCW predominantly located to the west of the study area would suggest that a 50m buffer/development setback surrounding these wetlands would be appropriate.

The development of 'Special Residential' areas does not require provision for POS, and therefore a Foreshore Reserve is generally not required. However, the above policies and guidelines should be used to guide placement of the building envelopes to provide adequate protection for the streamline and riparian vegetation and to ensure maintenance structural integrity of future residences.

Based upon the environmental assessment discussed in **Section 2**, a foreshore setback of approximately 30m from the extent of the riparian vegetation is recommended in order to protect the flora values of the Collie River floodplain within the study area, and a Building Envelope Exclusion Area encompassing the entire Collie River floodplain and EPP wetlands is recommended in order to protect the flood conveyance functions of the Collie River floodplain. It is therefore recommended that protection of riparian vegetation, wetland vegetation and overall site flora values is achieved through the use of a designated Foreshore Reserve that encompasses the 30m foreshore setback, 50m EPP wetland buffers and ESAs. The recommended Foreshore Reserve and Building Envelope Exclusion Area are consistent with *Guidance Statement No. 33* (EPA, 2005), WAPC Policy DC 2.3, and the buffer distances required for EPP wetlands. It is recommended that the Foreshore Reserve be given up to the Shire by the developer at the time of subdivision. Building Envelope Exclusion Areas are suitable for inclusion within private lot boundaries, but it is not recommended that building envelopes are located in these areas. The recommended Foreshore Reserve and Building Envelope Exclusion Areas are shown in **Figure 7**.

Furthermore, it is recommended that a Foreshore Management Plan (FMP) be developed for the site at the time of subdivision to ensure that appropriate measures are in place to ensure that any restorative works carried out achieve an improvement in the overall flora values of the site.

4.3.2 Wetlands

As described in **Section 2.4**, within the southern portion of the site (i.e. the Collie River floodplain) contains three wetlands. Two of these wetlands are afforded statutory protection by the 1992 EPP. However, the boundaries of the wetlands and their buffers are not consistent with the actual on-ground location of the wetlands. The location of the wetlands was revised within the 2004 Revised Draft EPP, which is consistent with the on-ground locations of the wetlands. Given that the 2004 Revised Draft EPP is still in draft form, and that the 1992 EPP wetland boundaries are therefore the statutorily protected area, it is recommended that a re-evaluation of the wetland boundaries should be sought through the EPA prior to undertaking ground disturbing activities. Further, it is recommended that a 50m buffer around both Revised Draft EPP wetland locations is adopted.

The current proposal does not involve clearing any of the wetland areas, rather it would involve rehabilitation of the wetland areas where necessary, and restoration of some of the surrounding dryland buffer areas. The restoration of wetland areas should be further detailed in the FMP to be developed for the site at the time of subdivision. The lots and building envelopes proposed as a part of this development will take into account current State and local government policies, and residential development should be limited to areas outside the Foreshore Reserve and Building Envelope Exclusion Area (see **Section 4.3.1**) indicated in **Figure 7**.

Provided that the recommendations regarding the use of a designated Foreshore Reserve and Building Envelope Exclusion Area are adhered to, it is not anticipated that there will be any significant impacts to wetlands within the study area.

4.4 HYDROLOGY

Increasing the proportion of impervious areas within a catchment subsequently increases the volume of stormwater runoff in response to rainfall events. Impervious surfaces that are introduced with residential development include, roofs, driveways, paved areas and roads. Generally, as the density of development increases, so does the proportion of the catchment that ends up being impervious.

Guidance for the management of stormwater quality and quantity is provided to proponents in Western Australia wishing to undertake residential development in the *Stormwater Management Manual for Western Australia* (DOE, 2004). The general principles indicate that in terms of runoff volume, developments should aim to achieve a 'no net increase' to peak flows from storm events.

Given the low density of the development proposed for the site, it is not anticipated that the development will change the existing hydrological response of the study area. Therefore, it is not anticipated that additional runoff will enter the Collie River.

As the building envelopes will be located within the northern undulating plain portion of the study area, and this area is substantially elevated above the wetlands onsite, it is not anticipated that the minor increase in impervious areas due to roof construction will cause significant groundwater recharge or surface flows. Therefore, the potential to impact the hydrology of the wetland areas is considered to be low.

Ideally, drainage of road reserves could be achieved via the use of flush kerbing and will not utilise a piped drainage network. This will allow localised percolation of stormwater runoff into roadside swales. Given the horizontal and vertical separation between roads and wetlands it is not anticipated that the construction of roads will cause any change to the hydrological response of the study area.

The above measures will be further detailed in the Outline Development Plan, to be submitted and approved by the Shire of Harvey as a part of the re-zoning process and then accommodated at the time of subdivision.

4.5 FAUNA HABITAT

As indicated previously, it is recommended that the development of the study area will involve retaining all riparian vegetation, vegetation within wetlands and as much of the remnant vegetation within the northern undulating plain as practically possible. Furthermore, as it is recommended that the riparian vegetation within floodplain will undergo some form of rehabilitation, it is anticipated that the fauna values of the site will increase, rather than decline. Restoration that will be undertaken should be detailed within the FMP to be developed for the site at the time of subdivision.

Given that the fauna habitat of value will be retained within the Foreshore Reserve and Building Envelope Exclusion Area it is not anticipated that there will be any significant impacts to the fauna habitat values of the site.

4.6 HERITAGE

There were no specific Aboriginal or European heritage values identified for the site. However, the Aboriginal Heritage Act 1972 protects sites of Aboriginal significance whether they are know or not. Therefore it is recommended that appropriate measures be taken to ensure that if any materials suspected of being of Aboriginal heritage significance are encountered at the time ground disturbing activities are undertaken. These are likely to include education of contractors as to the potential for archaeological material to be encountered during this time, and cease of works pending further identification should it occur.

4.7 HISTORIC AND SURROUNDING LAND USES

The majority of the land uses identified in proximity to the study area do not require buffer zones from the type of development proposed for the study area. While vineyards may sometimes require buffer zones, the scale of the observed viticulture can be considered to be minor (i.e. single lot). Given the existing separation distance of the vineyard from the study area and the recommended Building Envelop Exclusion Area, it is not considered that an additional buffer between this land use and the proposed development would be required.

5. CONCLUSIONS

The study area is composed of two widely differing landforms, being the previously cleared undulating northern portion and the Collie River and adjacent floodplain. The study area is proposed to be developed for 'Special Residential' purposes.

The soils underlying the site are predominantly sand over clay duplex soils, of varying depths. Topography of the site varies from 18mAHD under the undulating plain to 0-2mAHD within the floodplain of the Collie River. It is recommended that building envelopes should not be located within the seasonally inundated swamp (mapping unit P7 and test pit location RL4) due to the known soil properties of this area which are not readily excavated and are highly impermeable.

The shoreline of the Collie River and wetlands within the Collie River floodplain exhibit significant flora values. These areas also retain fauna habitat values. Furthermore, the floodplain also contains two EPP wetlands, which require buffers to minimise impacts to these areas. The location of proposed building envelopes should therefore take into consideration current state government policies regarding setbacks from wetlands as well as streamlines. Given that building envelopes would not be located within the Collie River floodplain, and that remnant vegetation within the northern portion of the site will be retained wherever possible, it is not anticipated that there will be any significant impacts to the flora values of the study area. Therefore the assessment of land qualities and the land capability assessment has been limited to the larger, undulating northern portion of the study area.

The land capability assessment conducted indicates that the site has a low capability for disposal of effluent via septic tanks. The low overall land capability class was triggered by the 'very low' microbial purification rating, and the 'high' risk of waterlogging. In the case of sites that have a 'low'

land capability extensive conservation measures may be required in order for the development to proceed. The recommended management option to address the low microbial purification ability and high waterlogging potential is to utilise Ecomax™ effluent treatment units which utilise inverted (partially above ground level) leach drains. The Ecomax™ units proposed provide the required microbial treatment function, and have been approved by the Health Department of Western Australia for use in areas with a high watertable or impermeable soils. Given that Ecomax™ treatment units are proposed to be utilised for effluent disposal, the study area can be considered to have a '2 - high' capability for residential subdivision, which indicates that there are only minor physical limitations that can be overcome by careful planning.

The current proposal can be considered to principally comply with the policies and guidelines discussed above, however as the proposed lot sizes are below the DPS No.1 minimum lot size of 4000m^2 within 'Special Residential' areas the Shire should be engaged at an early stage with a view to having the DPS amended as a part of the re-zoning process. Certain provisions should be included within the final subdivision design, including a designated Foreshore Reserve, inclusive of a 30m foreshore setback, EPP wetland buffers and ESAs, and import of fill materials in areas surrounding leach drains to ensure adequate treatment and dispersal of effluent.

5.1 RECOMMENDATIONS

Cardno BSD considers that the general environmental considerations relating to topography, soil, flora, wetlands, fauna and heritage for Lots 121, 246, 314 & 3315 Treendale Road, Roelands do not show characteristics that would preclude development of the majority of the northern portion of the study area for residential purposes.

However, in order for the development to proceed Cardno BSD recommends that:

- Onsite effluent disposal is achieved via the use of Ecomax™ treatment units;
- Measures to encourage adequate infiltration of leach drains are implemented, such as use of impermeable liners and import of amended soil;
- Locations of residential dwellings are within specified building envelopes;
- The development of the study area retains all riparian vegetation, vegetation within wetlands and as much of the remnant vegetation within the northern undulating plain as practically possible;
- The vegetation adjacent to the Collie River should be protected by a 30m wide foreshore setback that extends from the upper edge of the existing riparian vegetation;
- A re-evaluation of the 1992 EPP wetland boundaries should be sought through the EPA prior to undertaking ground disturbing activities;
- A 50m buffer surrounding the locations of the two Revised Draft EPP wetland locations is adopted;
- The streamline and wetland areas undergo some form of restoration works to improve their flora and fauna habitat values;
- A Foreshore Reserve encompassing the 30m foreshore setback, EPP wetland buffer areas and ESAs are physically demarked by a pathway, fence or other suitable method;

- A Foreshore Management Plan (FMP) be developed for the study area at the time of subdivision;
- A Building Envelope Exclusion Area encompassing the entire Collie River floodplain, EPP wetlands and the (P7) seasonally inundated swamp area is adopted;
- Drainage of roads is achieved via the use of flush-kerbing; and
- Appropriate measures are taken to protect any materials suspected of being of Aboriginal heritage significance are encountered at the time ground disturbing activities.

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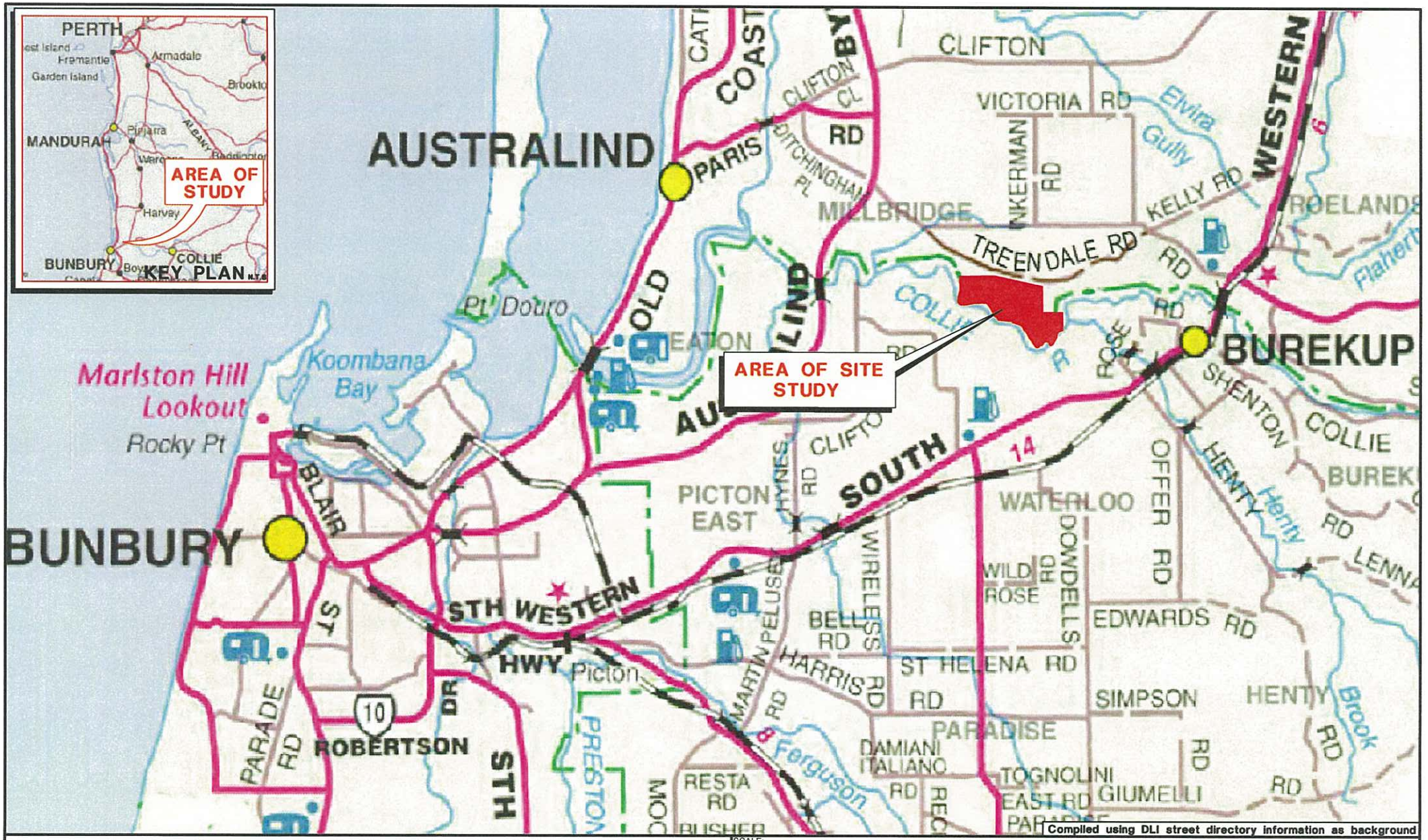
FIGURES



Compiled using DLI street directory information as background

PROJECT **Roelands Environmental Assessment**

DRAWING TITLE **Figure 1: Roelands, Lots 121, 246, 314 & 3315 Locality Map**

PRINCIPAL **Collie River Investments Pty Ltd**

SCALE: **Not to Scale**

N W E S

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Project Number	Drawing Number	Revision	Original
V6003	SK01		A4

Designed MG	Checked DPC	Date	22/02/06
Drawn MG	Approved JDH	Sheet	Of
Local Authority	SHIRE OF HARVEY		

878

TREENDALE ROAD

RL9

RL8

RL5

RL3

RL1

RL6

RL2

RL10

RL7

RL11

RL4

RL12

3

Collie

166

VCL

0

VCL

RL13

River

424

RL14

212

333

209

N

W

E

S

LEGEND

Soil Landscape Mapping Units:

P1a	Flat to gently undulating plain with acidic mottled yellow duplex (or "effective duplex") soils comprising of shallow pale sand to sandy loam over clay; imperfect to poorly drained and generally not susceptible to salinity.
P1b	Flat to gently undulating plain with acidic mottled yellow duplex (or "effective duplex") soils comprising of moderately deep pale sandy loam over clay; imperfectly drained and moderately susceptible to salinity in limited areas.
P7	Seasonally undulated swamps and depressions with very poorly drained variable acidic mottled yellow and grey duplex soils.
P10	Gently undulating to flat terraces adjacent to major rivers, but below the general level of the plain. Deep to well drained uniform brownish sands or loams subject to periodic flooding.
Sw	Miscellaneous swamps

*Note: Source of data from Barnesty & Proulx-Nixon (1994)

RL1 ● Test Pit location

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT: **Roelands Environmental Assessment**

DRAWING TITLE: **Figure 2: Land Units and Test Pit Locations**

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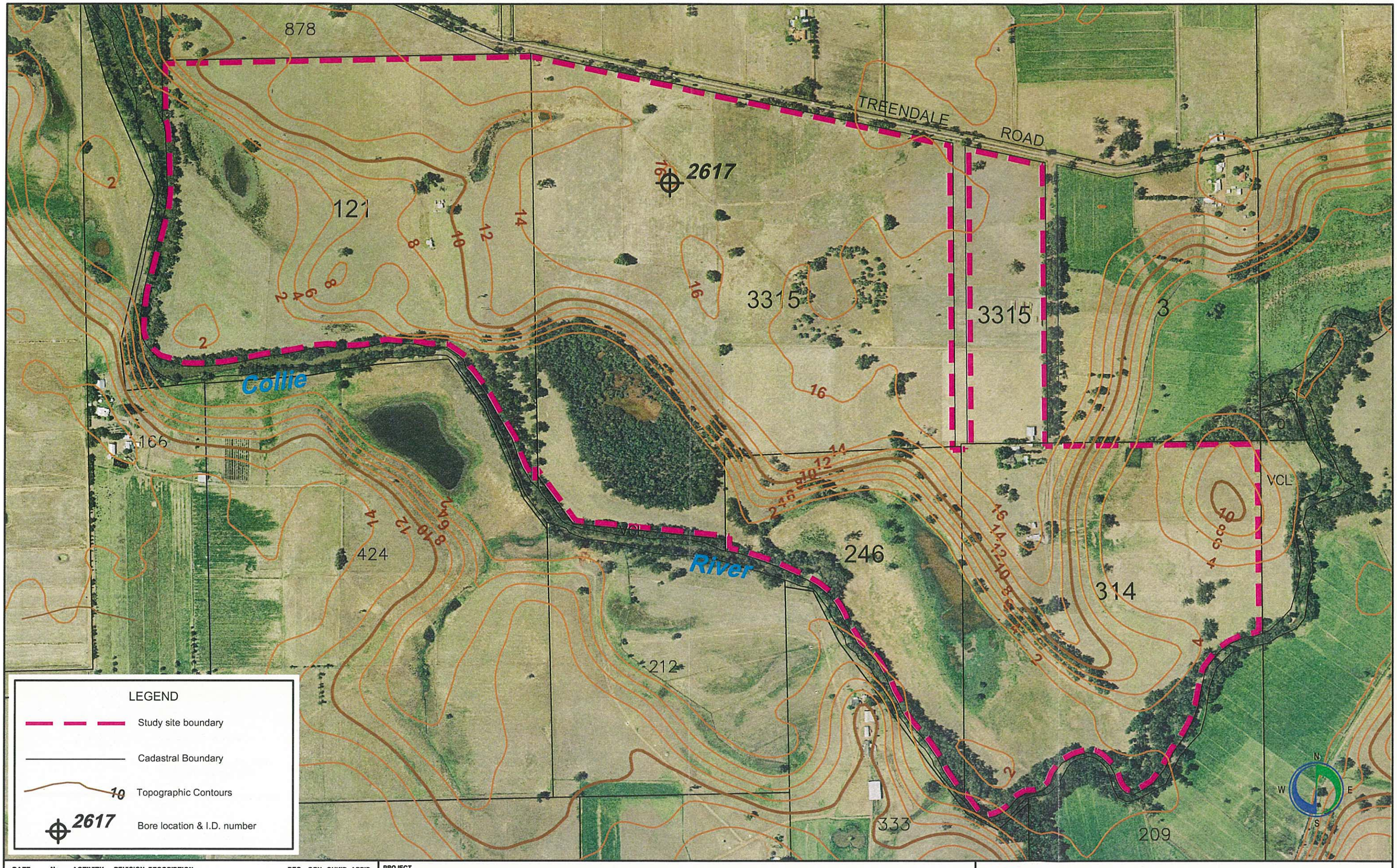

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PROJECT: **Roelands Environmental Assessment**

DRAWING TITLE: **Figure 3: Lot Boundaries and Topographic Contours**

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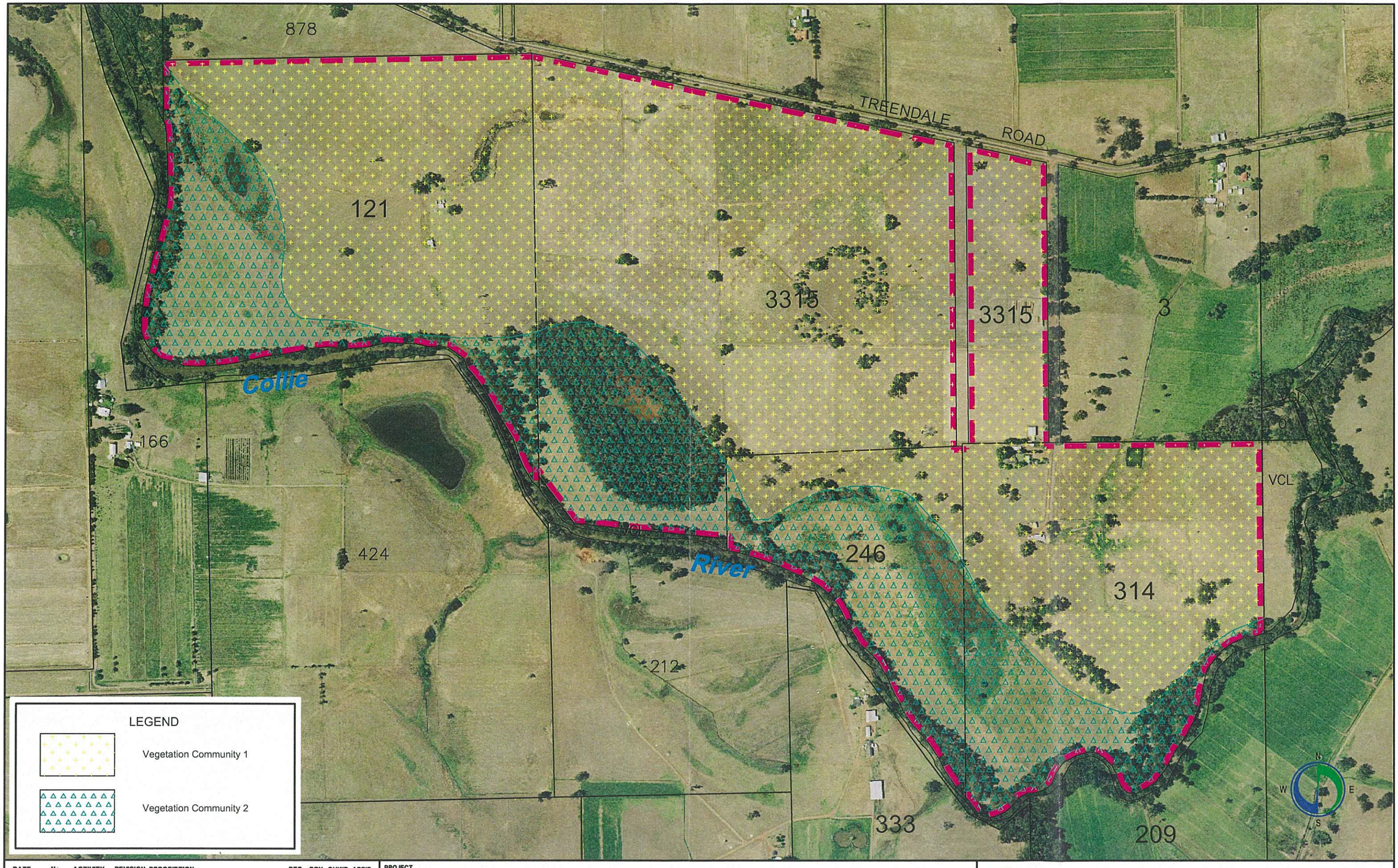

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PROJECT: **Roelands Environmental Assessment**

DRAWING TITLE: **Figure 5: Vegetation Communities**

PRINCIPAL: **Collie River Investments**

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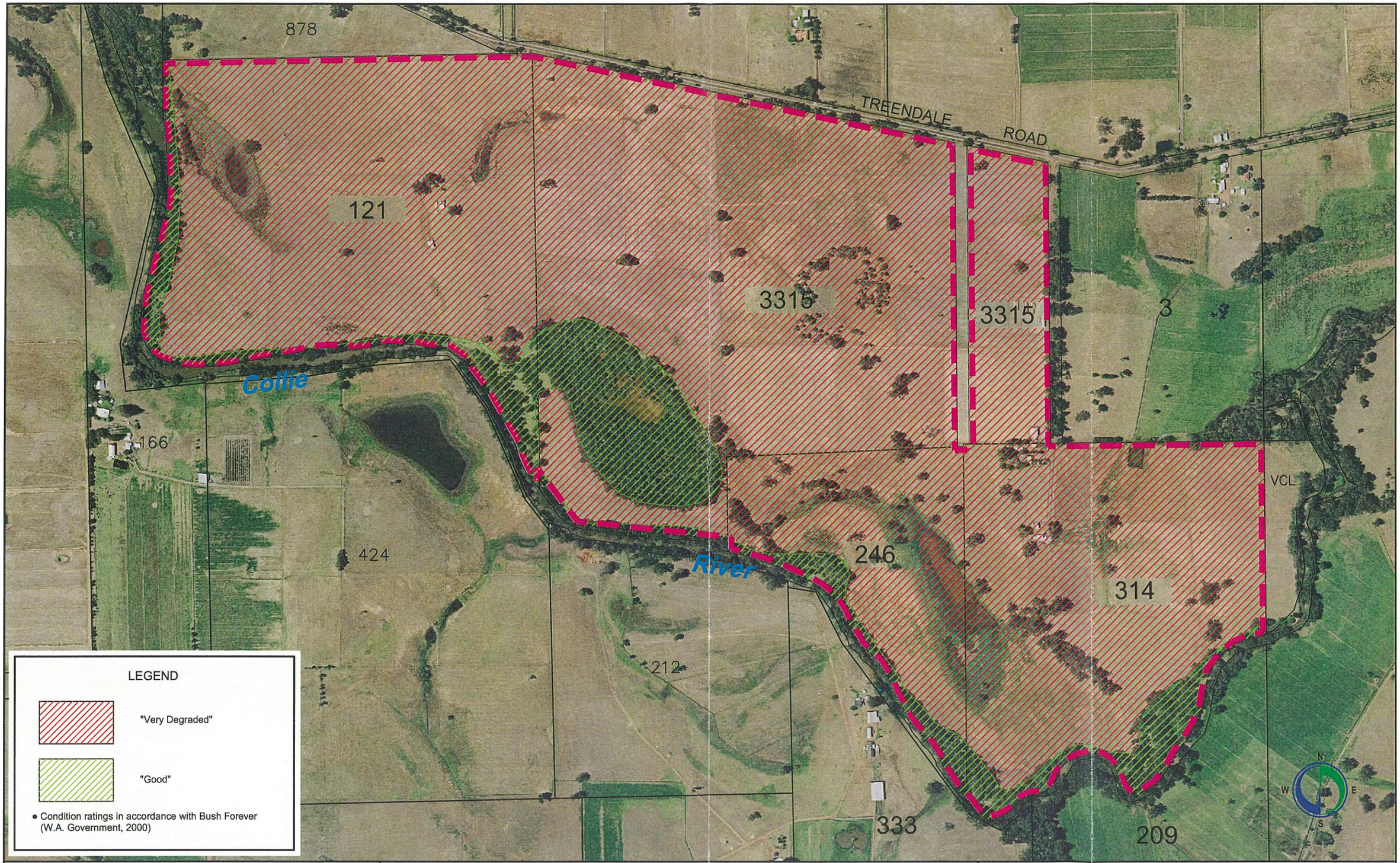

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT: **Roelands Environmental Assessment**

DRAWING TITLE: **Figure 6: Vegetation Condition**

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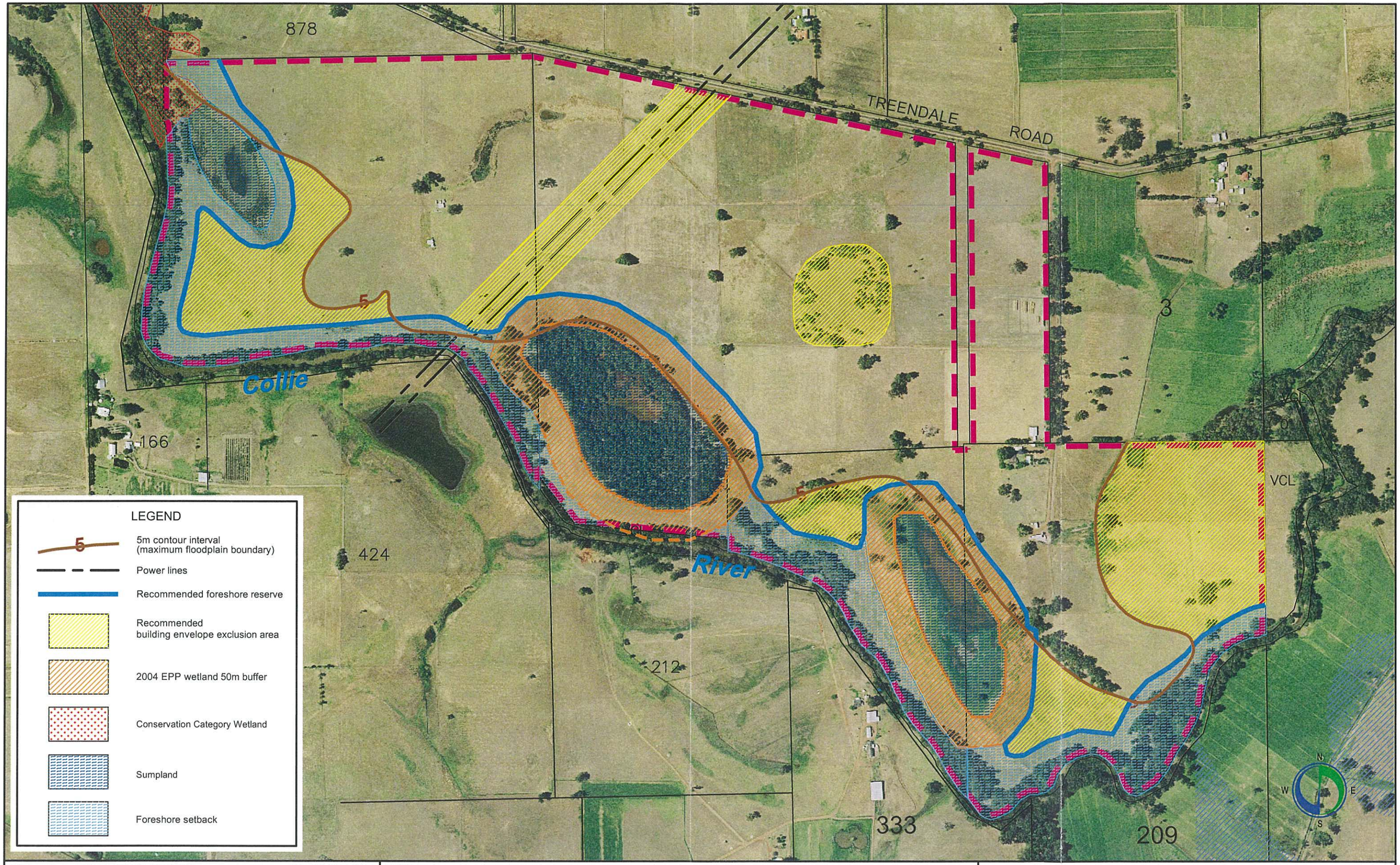

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT
Roelands Environmental Assessment

DRAWING TITLE
Figure 7: Recommended Foreshore Reserves & Building Envelope Exclusion Areas

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Project Number V6003	Drawing Number SK07	Revision	

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Appendix A

DRF and Priority Flora Database Search

Total No. of Records = 16

Species Name	Cons.	Pop ID	No. Plants	Latitude	Longitude	Purpose	Vest
Anthotium junciforme	4	9		33^20'35.7"	115^46'15.4"	Road Verge	SHI
Aponogeton hexatepalus	4	16A	430	33^19'54.7"	115^45'17.4"	Railway Reserve	RAI
	4	16B	420	33^19'54.7"	115^45'17.4"	Railway Reserve	RAI
	4	16C	570	33^19'52.7"	115^45'23.4"	Railway Reserve	RAI
	4	16D	370	33^19'50.7"	115^45'26.4"	Railway Reserve	RAI
	4	16E	123	33^19'48.7"	115^45'31.4"	Railway Reserve	RAI
	4	16F	822	33^19'47.7"	115^45'33.4"	Other	MWO
	4	16G	1500	33^19'42.7"	115^45'47.4"	Other	NON
	4	16H	220	33^19'43.7"	115^45'50.4"	Other	NON
	4	16I	16	33^19'45.7"	115^45'43.4"	Railway Reserve	RAI
	4	16J		33^19'51.7"	115^45'27.4"	Railway Reserve	RAI
	4	23	10	33^19'35.7"	115^47'00.4"	Railway Reserve	RAI
Caladenia speciosa	4	8		33^17'55.7"	115^44'05.4"		UNK
Drosera marchantii subsp. marchantii	C	2	30	33^20'07.7"	115^45'23.4"	Railway Reserve	RAI
Rhodanthe pyrethrum	3	2		33^20'07.7"	115^45'23.4"	Railway Reserve	RAI
	3	4A		33^19'10.7"	115^44'11.4"	Road Verge	SHI

Appendix B

Priority Fauna Database Search

33.2462 °S 115.722 °E / 33.3539 °S 115.83 °E Roelands (plus 5km buffer)

*	Date	Certainty	Seen	Location Name	Method

Schedule 1 - Fauna that is rare or is likely to become extinct

Pseudocheirus occidentalis **Western Ringtail Possum** *1 records*

This species occurs in areas of forest and dense woodlands and requires tree hollows and/or dense canopy for refuge and nesting.

2005	1	1	Burekup	Dead

Schedule 4 - Other specially protected fauna

Falco peregrinus **Peregrine Falcon** *1 records*

This species is uncommon and prefers areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land.

1975	1	1	Brunswick	Day sighting

* Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

Appendix C

Threatened Ecological Community Database Search

17. SCP3c Eucalyptus calophylla - Xanthorrhoea preissii woodlands and shrublands, Swan Coastal Plain

Has the community been endorsed by the Minister for Yes
Current Category: Critically Endangered

Occ.	Buffer		Datum	Longitude	Latitude
22.	500	Site ID	Datum	Longitude	Latitude
		WATER05	GDA94	115° 46' 5"	-33° 19' 32"
25.	500	Site ID	Datum	Longitude	Latitude
		WATER03	GDA94	115° 45' 38"	-33° 19' 47"

33. SCP08 Herb rich shrublands in clay pans

Has the community been endorsed by the Minister for Yes
Current Category: Vulnerable

Occ.	Buffer		Datum	Longitude	Latitude
9.	1000	Site ID	Datum	Longitude	Latitude
		WATER04	GDA94	115° 45' 44"	-33° 19' 44"

Appendix D

Soil Profile Log Sheets

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL1		Time	0830
GPS Location			Drill Method	Excavator			
E 386706	N 6314917						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sand	Pale grey	dry	even	Fine grain	
		Clay	Yellow	moist	highly plastic		
1m							
		Clay	Mottled Red/grey	moist	even	Very heavy	
2m							
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL2		Time	0905
GPS Location			Drill Method	Excavator			
E 386580	N 6314848						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sandy clay	Pale grey	dry	even	clumping	
		Clay	Yellow	moist			
			gravelly				
1m							
		Clay	Mottled	moist	Uneven	gritty	
			Red/grey				
2m		Clay	yellow		even	heavy	
					solid		
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL3		Time	0930
GPS Location			Drill Method	Excavator			
E 386329	N 6314901						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven	Fine grain	
		Sandy Quartz	Pale grey	dry	even		
1m		Clay	Yellow	moist	uneven	Medium/coarse	
			gravelly				
2m							
		Clay	yellow		even	heavy	
					solid		
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL4		Time	1000
GPS Location			Drill Method	Excavator			
E 386455	N 6314754						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Loamy sand	dry	uneven	Fine grain	
		Clay	Brown	dry	uneven	Coarse grain	
		Clay	White/grey	dry	uneven	Very hard	
						packed	
1m							
		rock	cemented	dry		Very hard	
			Laterite &			packed	
			clay				
2m	End of	hole					
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL5		Time	1035
GPS Location			Drill Method	Excavator			
E 386029	N 6314881						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sandy clay	Pale grey	dry	even	Quartz, fine grain	
1m		Clay	Mottled	moist	Uneven	gritty	
			Red/grey				
2m		Clay	yellow	moist	even	highly	
					solid	plastic	
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL6		Time	1110
GPS Location			Drill Method	Excavator			
E 385856	N 6314832						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Loamy sand	dry	uneven	Fine grain	
		Sandy clay	Pale grey	dry	even	fine grain	
		Clay	Yellow/	dry	uneven	slightly	slightly
			orange			cemented	mottled
1m							
		Clay	Mottled	moist	Uneven	gritty	Highly
2m			Red/grey				plastic
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL7		Time	1125
GPS Location			Drill Method	Excavator			
E 385641	N 6314736						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Loamy earth	dry	uneven	Fine grain	
		Earthy	red	dry	small even	slightly	
		Clayey				plastic	
		sand					
1m							
2m							
		Clay	Mottled	moist	Uneven	gritty	
3m			Red/grey				
End of	hole						
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL8		Time	1145
GPS Location			Drill Method	Excavator			
E 385596	N 6314907						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	hard loamy earth	dry	uneven	Fine grain	
		Earthy	red	dry	small even	slightly	
		Clayey				plastic	
		Clay	Red/orange	moist	Uneven	Highly	Hard
1m						plastic	packed
2m							
		Clay	mottled	moist	uneven	gritty	Highly
3m			red/grey				plastic
End of	hole						
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL9		Time	1205
GPS Location			Drill Method	Excavator			
E 386549	N 6315024						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Sandy earth	dry	uneven		
		Clayey sand	Pale grey	dry	even	fine grain	
		Clay	Bright	moist	even	highly	
		gravelly	yellow		solid	plastic	
1m							
		Clay	Mottled	moist	Uneven	gritty	Highly
			Red/grey				plastic
2m							
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL10		Time	1235
GPS Location			Drill Method	Excavator			
E 386426	N 6314717						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven	Fine grain	
		Loamy	brown	dry	uneven	grainy	
		earth					
1m							
		Clay	orange	moist	uneven	Fine grained	Highly
			gravelly				plastic
2m							
3m		Clay	Mottled	wet	even	Highly plastic	
			Grey/yellow				
End of	hole						
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL11		Time	1310
GPS Location			Drill Method	Excavator			
E 386098	N 6314724						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sandy clay	Light brown	dry	uneven	+fines	
		Clay	Yellow	dry	even	clumping	medium
							grained
1m							
		Clay	Mottled	dry	Uneven	gritty	
			Red/grey				
2m		Clay	Pale grey	dry		Highly	
						plastic	
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL12		Time	1330
GPS Location			Drill Method	Excavator			
E 386697	N 6314595						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Peaty sand	dry	uneven		
		Sandy	Yellow	dry	even	clumping	medium
		Clay					grained
1m							
		Clay	Mottled	dry	Uneven	Highly	
2m			brown/grey			plastic	
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL13		Time	1400
GPS Location			Drill Method	Excavator			
E 387061	N 6314364						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Earthy	red	dry	even	slightly	
		Clayey			Fine	plastic	
		sand			grained		
1m							
		Gravely	Yellow/	dry	Coarse	quartz	
		Clay	orange		grained		
2m							
End of	hole						
3m							
4m							

Project: V6003 Roelands Land Capability
Location: Lots 121, 246, 314 & 3315 Treendale Rd, Roelands
Client: Collie River Investments

Name	D Coremans		Date	2/2/06		RL Surface	
Operator Name		Butler's	Hole ID #	RL14		Time	1430
GPS Location			Drill Method	Excavator			
E 386809	N 6314105						
Depth (m)	Graphic Log	Class.	Description	Moisture	Consistency	Structure	Other
0m							
		Topsoil	Clayey earth	dry	uneven		
		Clay/	red	Dry	even		
		Sandy					
		clay					
1m							
		clay	Solid white/	dry	uneven	Hard	cemented
			grey			packed	
2m	End of	hole					
3m							
4m							

Appendix E

Soil Sample Analysis Results

00067051
Cardno BSD
PO Box 155
SUBIACO
6904

CSBP ANALYSIS REPORT

RECEIVED
BSD CONSULTANTS
16 FEB 2006
ACTION
FILE

Date - . . . 13/0
Time - . . . 14:1

Job: DQS06
O/N:
Date Received: 07/02/06
NON ROUTINE

COREMANS DAVID V6003

Sample number:	RL1	RL2	RL3	RL4	RL7	RL8	Scheme	Units
Serial Number:	RL1	RL2	RL3	RL4	RL7	RL8		
Lab number:	DQS06104	DQS06105	DQS06106	DQS06107	DQS06108	DQS06109		
Texture							SRC001	
Gravel							SRC001	%
Colour							SRC001	
Nitrate Nitrogen							SNN001	mg/Kg
Ammonium Nitrogen							SNN001	mg/Kg
Phosphorus Colwell	41	16	8	21	11	77	SPK001	mg/Kg
Potassium Colwell	49	55	35	85	131	93	SPK001	mg/Kg
Sulphur							SSU001	mg/Kg
Organic Carbon							SOC001	%
Reactive Iron							SFE001	mg/Kg
Conductivity							SPH001	dS/m
pH Level (CaCl2)							SPH001	pH
pH Level (H2O)							SPH001	pH
Total Phosphorus	110	67	66	101	145	458	STP001	mg/Kg
Phosphorus Retention	1.8	59.7	6.5	76.2	115.1	159.6	SPR001	
EMP Exchangeable	.00	.00	.00	.00	.00	.00	SMG001	

00067051
Cardno BSD
PO Box 155
SUBIACO
6904

CSBP

A N A L Y S I S R E P O R T

RECEIVED
BSD CONSULTANTS
16 FEB 2006
RL14
RL14
ACTION
FILE
DQS06114
V6003

Date - . . . 13/0
Time - . . . 14:1

Job: DQS06
O/N:
Date Received: 07/02/06
NON ROUTINE

COREMANS DAVID V6003

Sample number:	RL9	RL10	RL11	RL13		Scheme	Units
Serial Number:	RL9	RL10	RL11	RL13			
Lab number:	DQS06110	DQS06111	DQS06112	DQS06113			
Texture						SRC001	
Gravel						SRC001	%
Colour						SRC001	
Nitrate Nitrogen						SNN001	mg/Kg
Ammonium Nitrogen						SNN001	mg/Kg
Phosphorus Colwell	71	14	27	103	174	SPK001	mg/Kg
Potassium Colwell	289	54	83	338	374	SPK001	mg/Kg
Sulphur						SSU001	mg/Kg
Organic Carbon						SOC001	%
Reactive Iron						SFE001	mg/Kg
Conductivity						SPH001	dS/m
pH Level (CaCl2)						SPH001	pH
pH Level (H2O)						SPH001	pH
Total Phosphorus	442	315	132	435	562	STP001	mg/Kg
Phosphorus Retention	36.0	1,427.7	55.8	71.2	80.7	SPR001	
EMP Exchangeable	.00	.00	.00	.00	.00	SMG001	

PLATES

Plate 1 Test Pit RL1

Plate 2 Test Pit RL2

Plate 3 Test Pit RL3

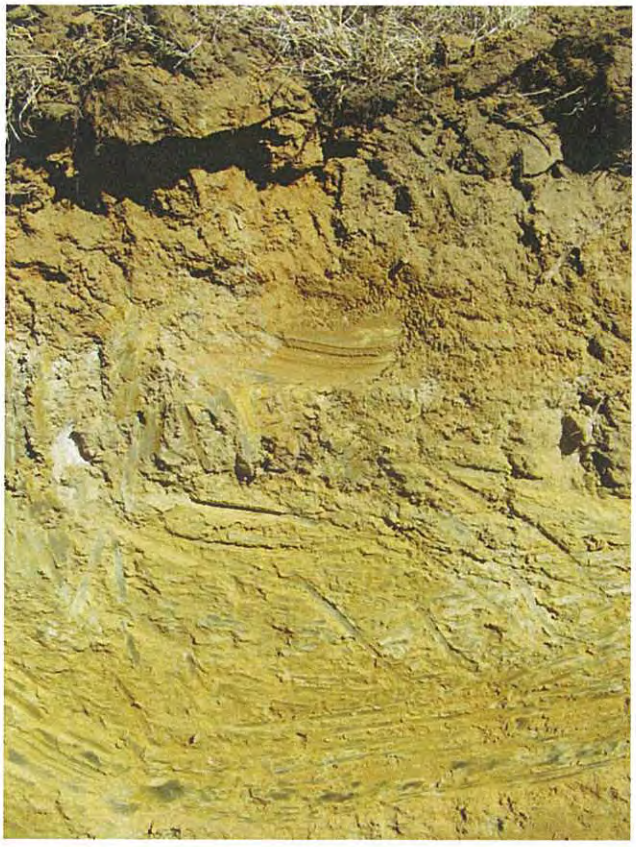

Plate 4 Test Pit RL4

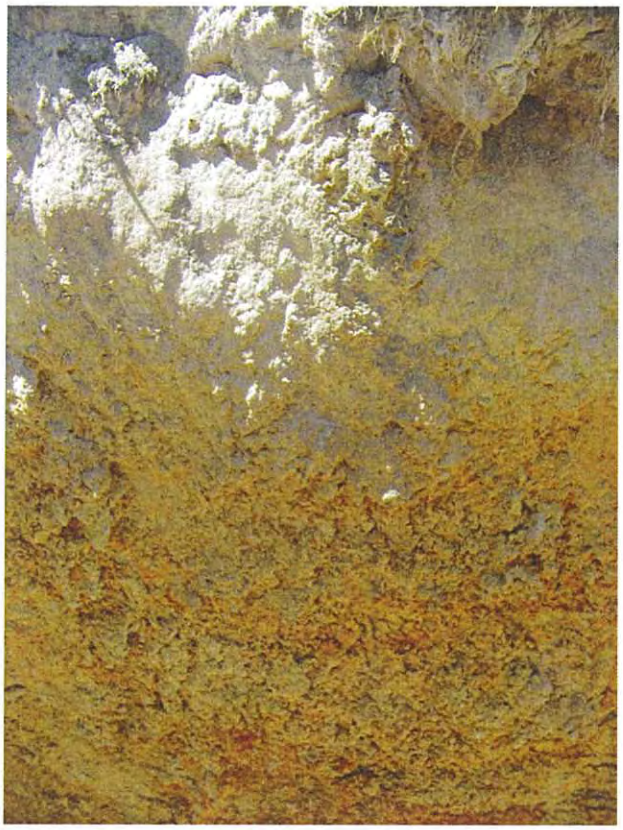

Plate 5 Test Pit RL5

Plate 6 Test Pit RL6

Plate 7 Test Pit RL7

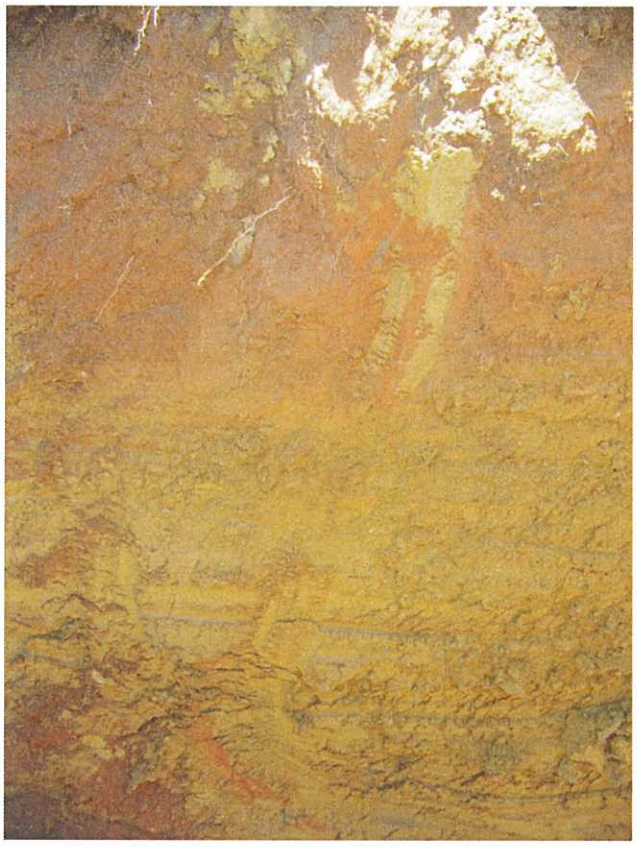

Plate 8 Test Pit RL8

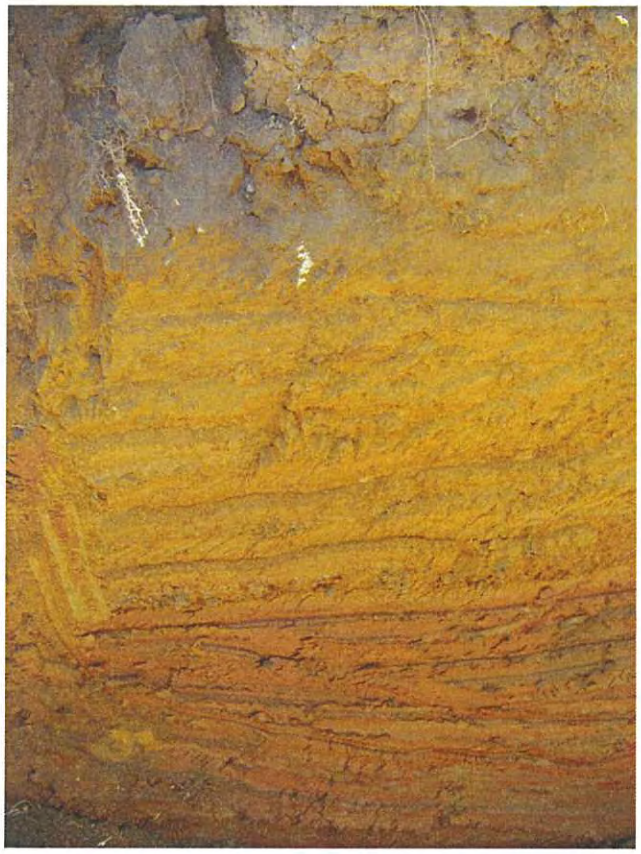

Plate 9 Test Pit RL9

Plate 10 Test Pit RL10

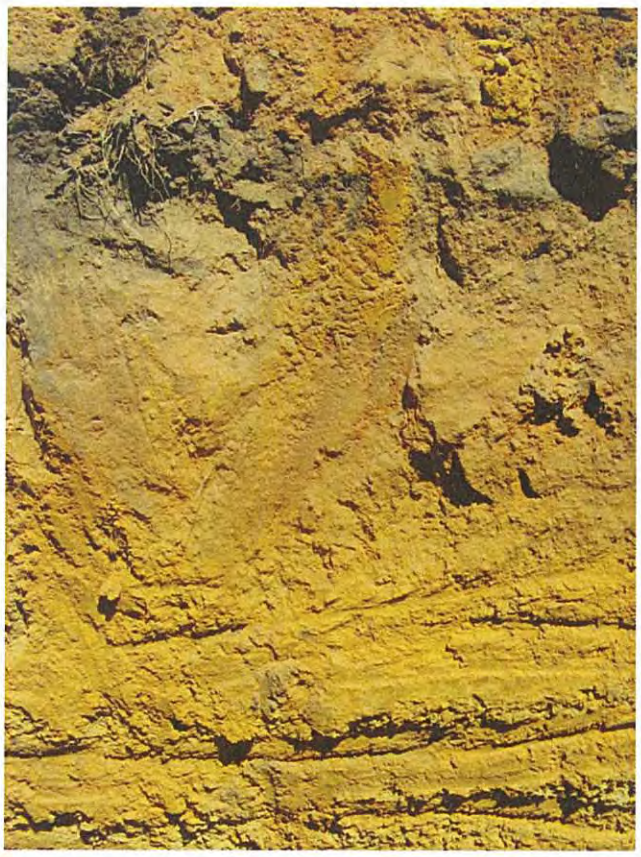

Plate 11 Test Pit RL11

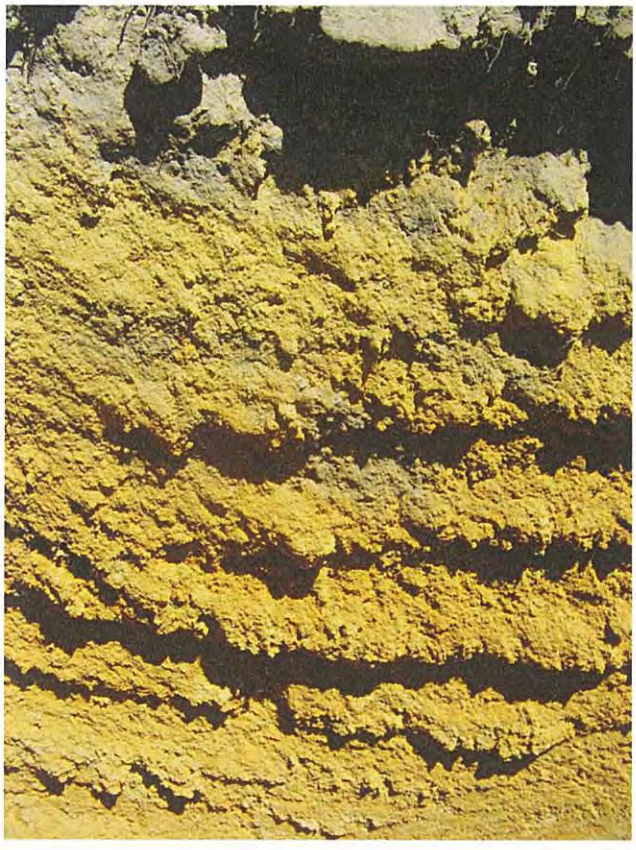

Plate 12 Test Pit RL12

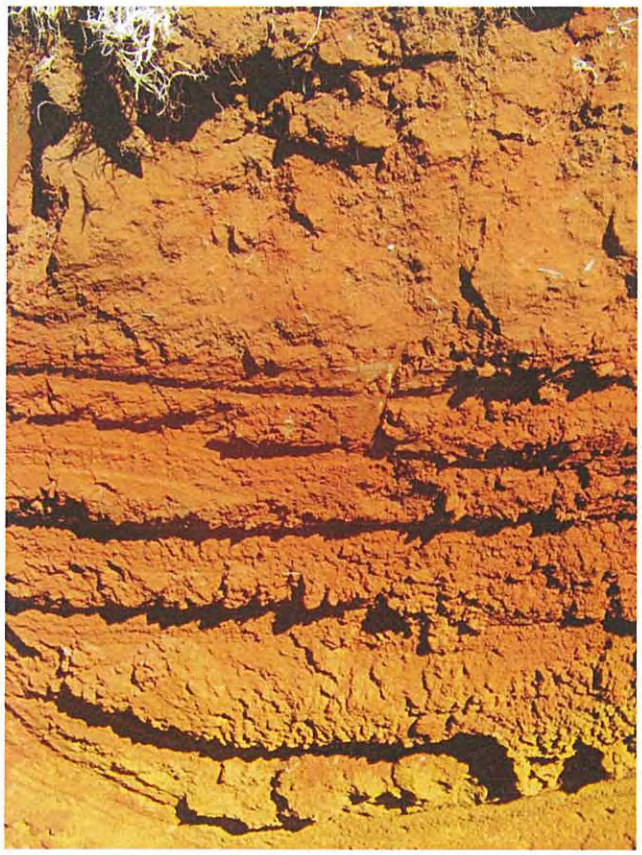

Plate 13 Test Pit RL13

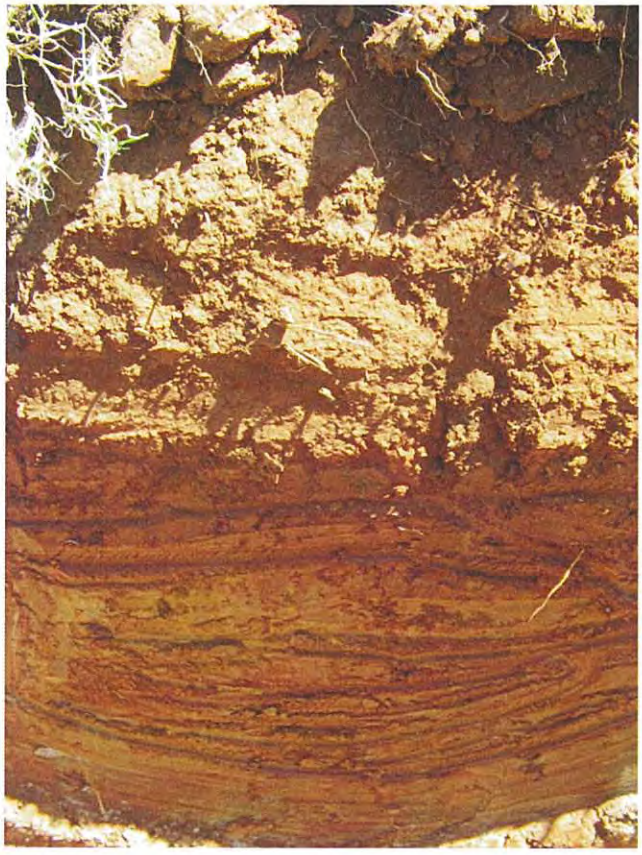

Plate 14 Test Pit RL14

Plate 15 Condition of vegetation in northern portion of study area – eastern end

Plate 16 Condition of vegetation in north portion of study area – western end

Plate 17 Condition of vegetation along Collie River (pt 1)

Plate 18 Condition of vegetation along Collie River (pt2)

Plate 19 Condition of 'sumpland' area within wetland #1736

Plate 20 Condition of wetland #1869

Plate 21 Condition of wetland #1718

Appendix B

Geotechnical Investigation (Golder and Associates, 2017)

14 August 2017 Document No. 1772403-006-L-Rev0

Andrew McIntyre

e-mail: andrew.mcintyre@outlook.com.au

GEOTECHNICAL REPORT ON 260 TREENDALE ROAD, ROELANDS

Dear Andrew,

1.0 INTRODUCTION

This letter presents the results of a preliminary geotechnical investigation undertaken by Golder Associates Pty Ltd (Golder) for 260 Treendale Road, Roelands.

We understand the site is being considered for future land development opportunities. The site locations are shown on Figure 1, Location Plan.

The overall aim of the work was to provide a preliminary assessment of the geotechnical suitability of the site for future land development. The objectives of the study were to assess the subsurface soil and groundwater conditions across the site.

2.0 FIELDWORK

The fieldwork was conducted on 13 January 2017 and comprised:

- Excavation of test pits at eighteen locations, T-TP1 to T-TP18, extending to depths of between 1.3 m and 2.5 m.
- Testing with a dynamic cone penetrometer (DCP) adjacent to each test pit, extending to depths of up to 1.05 m.

The test locations were recorded using a hand held GPS accurate to about 5 m. Test pit locations for the site are shown on Figure 2.

Test pits were excavated using a mini-excavator supplied and operated by DRS Contracting. The test pit reports are presented in Attachment A, along with a list of notes and abbreviations and a description of the soil classification system used on the reports.

PSP and DCP testing was undertaken in accordance with test method AS 1289.6.3.3 and AS 1289.6.3.2, except that the depth of testing was greater than covered by the standard for PSP testing and the blow counts was recorded at 150 mm intervals for the DCP testing. The results are provided on the relevant test pit reports.

A geotechnical engineer from Golder located the tests, logged the materials encountered in the test pits, collected soil samples and conducted the penetrometer testing.

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3.0 SITE CONDITIONS

3.1 Regional Geology

The Bunbury-Burekup sheet of the 1:50,000 Environmental Geology Series maps indicate that the site is likely to be underlain by Guildford Formation "*mainly alluvial sandy clay*".

3.2 Topography and Site Features

The site is relatively flat (based on available 1 m contours) with a slope from east to west across the site. The eastern edge of the lots is at approximately RL 17 m AHD falling to approximately RL 14 m AHD at the western edge of the lots. The total area of the site is approximately 260 ha and is generally bounded by Treendale Road to the south and farmland to the north, east and west. Raymond Road crosses the site in an east-west direction.

The site is predominantly cleared of vegetation, with a covering of grass and sparsely spaced mature trees. A number of surface water features can be identified across the site.

The southern edge of the lots is located approximately 0.3 km to 0.5 km from the Collie River. The available topographic information indicates that the Collie River main channel and adjacent floodplain is more than about 10 m lower than the Raymond Road sites.

3.3 Subsurface Profile

Based on the field investigation results, subsurface conditions at the Roelands site at the time of the investigation can be generalised as follows:

- TOPSOIL – Silty SAND (SM): fine to medium grained, black, ~10-15% low plasticity fines, trace organics, loose to medium dense, moist to dry, extending from the ground surface to depths of between about 0.15 m and 0.2 m, overlying
- Clayey SAND (SC): fine to medium grained, yellow, grey, low to medium plasticity, generally medium dense to dense, dry to moist, containing weakly to well cemented (laterised) zones, extending to depths of between 0.4 m and the maximum depth investigated of 2.5 m, overlying

CLAY/Sandy CLAY (CI-CH): medium to high plasticity, fine to medium grained, grey with red and orange mottling, generally stiff to very stiff, containing weakly cemented zones, extending to the maximum depth investigated of 2.5 m.

3.4 Groundwater

Groundwater was encountered at one location, T-TP8, at the Roelands site at a depth of 2.5 m below ground level.

Given the time of the year at which the investigation was performed, groundwater may be more than 1 m higher following winter rainfall. During wet periods water is likely to perch on the clayey soils encountered at the Roelands site, leading to inundation.

4.0 PRELIMINARY ASSESSMENT

Clayey soils were encountered below a thin covering of topsoil during the preliminary field investigation and are generally considered likely to be moderately reactive. Moderately to highly reactive clay may result in reduced bearing capacity for shallow footings, thicker pavement design and increased surface movement due to shrink-swell effects between wet and dry seasons. Sand fill will need to be placed to provide adequate on-site drainage, improve subgrade conditions for pavements and limit the effect of shrink-swell movements.

The clay was generally stiff to hard; however, a zone of soft clay was encountered at one location and the potential for localised soft zones to be present elsewhere cannot be discounted. Surficial clayey soils are likely to soften in winter, particularly where surface water is unable to drain freely.

Groundwater was only encountered at one location during the preliminary field investigation; however, perched groundwater/surface water may occur at the site during winter months due to the presence of clayey soils at the surface.

Given the presence of clayey soils from close to the surface, there is expected to be very limited potential to infiltrate surface water via swales or basins at the site.

GOLDER ASSOCIATES PTY LTD

Simon Hope
Senior Geotechnical Engineer

SL/SNH/sl

Attachments: Figure 1 – Location Plan
Figure 2 – Roelands Site Plan
A – Test Pit Reports

REFERENCE

AERIAL IMAGERY SOURCED FROM NEARMAP. DATED NOVEMBER 2016 / MAY 2017..

CADSTRAL BASED ON INFORMATION PROVIDED BY AND WITH THE PERMISSION OF THE WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2017)

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

0 1,000 2,000
1:50,000 METRES

CLIENT
MR ANDREW MCINTYRE

PROJECT
260 TREENDALE ROAD, ROELANDS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-08-14
DESIGNED	SNH
PREPARED	JRP
REVIEWED	SNH
APPROVED	SNH

TITLE
LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1772403	006 L	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

Path: B:\99_PROJECTS\1772403_SN02_PRODUCTION\MXD\006-L\Rev0\1772403-006-L-F001-Rev0.mxd

LEGEND

TEST PIT LOCATION

REFERENCE

CADSTRAL BASED ON INFORMATION PROVIDED BY AND WITH THE PERMISSION OF THE WESTERN AUSTRALIAN LAND INFORMATION AUTHORITY TRADING AS LANDGATE (2017).

AERIAL IMAGERY SOURCED FROM NEARMAP. DATED MAY 2017.

NOTES

1. COORDINATE SYSTEM: GDA 1994 MGA ZONE 50

0 100 200
1:4,000 METRES

CLIENT
MR ANDREW MCINTYRE

PROJECT
260 TREENDALE ROAD, ROELANDS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-08-14
DESIGNED	SNH
PREPARED	JRP
REVIEWED	SNH
APPROVED	SNH

TITLE
ROELANDS SITE PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
1772403	006 L	0	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

0

ATTACHMENT A
Test Pit Reports

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT REPORTS

DRILLING/EXCAVATION METHOD

AS*	Auger Screwing	RD	Rotary blade or drag bit	HQ	Diamond Core - 63 mm
AD*	Auger Drilling	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
*V	V-Bit	RAB	Rotary Air Blast	NQ	Diamond Core - 47 mm
*T	TC-Bit, e.g. ADT	RC	Reverse Circulation	BH	Tractor Mounted Backhoe
HA	Hand Auger	PT	Push Tube	EX	Tracked Hydraulic Excavator
ADH	Hollow Auger	CT	Cable Tool Rig	EE	Existing Excavation
DTC	Diatube Coring	JET	Jetting	HAND	Excavated by Hand Methods
WB	Washbore or Bailer	NDD	Non-destructive drilling		

PENETRATION/EXCAVATION RESISTANCE

L **Low resistance.** Rapid penetration possible with little effort from the equipment used.

M **Medium resistance.** Excavation/possible at an acceptable rate with moderate effort from the equipment used.

H **High resistance** to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.

R **Refusal or Practical Refusal.** No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.

These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.

WATER

▽	Water level at date shown	◁	Partial water loss
▷	Water inflow	◀	Complete water loss

GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (s_v = peak value, s_r = residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure tests

Ranking of Visually Observable Contamination and Odour (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible contamination	R = B	Slight non-natural odours identified
R = 2	Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

$$= \frac{\textit{Length of core recovered}}{\textit{Length of core run}} \times 100$$

SCR = Solid Core Recovery (%)

$$= \frac{\sum \textit{Length of cylindrical core recovered}}{\textit{Length of core run}} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum \textit{Axial lengths of core} > 100\ \textit{mm}}{\textit{Length of core run}} \times 100$$

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT REPORTS

 FILL

 GRAVEL (GP or GW)

 SAND (SP or SW)

 SILT (ML or MH)

 CLAY (CL, CI or CH)

 ORGANIC SOILS (OL or OH or Pt)

 COBBLES or BOULDERS

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

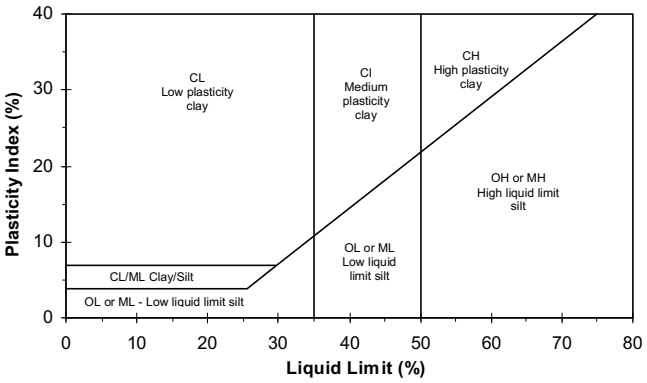
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. The material properties are assessed in the field by visual/tactile methods.

Particle Size

Major Division	Sub Division	Particle Size
BOULDERS		> 200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	20 to 63 mm
	Medium	6.0 to 20 mm
	Fine	2.0 to 6.0 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties



MOISTURE CONDITION

AS1726 - 1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays & Silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition & may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726 - 1993

Symbol	Term	Undrained Shear Strength
VS	Very Soft	0 to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa
H	Hard	Above 200 kPa

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	Less than 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Dense	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

SPT correlations are not stated in AS1726 – 1993, and may be subject to corrections for overburden pressure and equipment type.

REPORT OF TEST PIT: T-TP01

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 385894 m E 6315809 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					SM	Silty SAND fine to medium grained, black, ~10-15 % low plasticity silt, trace organics	M	L	~75mm of topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~30-40 % medium plasticity clay	D - M	MD - D		
			0.5										
			1.0							M			
			1.5	1.50	1.50 m Pocket Penotrometer = 1.8, 2.0 , 2.2 kg/cm2			CH	Sandy CLAY / CLAY fine to medium grained, quartz sand, low to medium plasticity, brown with orange, trace fine grained quartz gravel	M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP02

CLIENT:	Mr Andrew McIntyre	COORDS: 386023 m E 6315786 m N MGA94 50	SHEET: 1 OF 1
PROJECT:	260 Treendale Road, Roelands	SURFACE RL: DATUM: AHD	MACHINE: JCB 8035 ZTS
LOCATION:	260 Treendale Road, Roelands		CONTRACTOR: DRS Contracting
JOB NO:	1772403	PIT DEPTH: 2.00 m	LOGGED: DMS DATE: 13/1/17
		BUCKET TYPE: 600m toothed	CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0		BLK 0.70-0.90 m Rec = 200/200 mm Pocket Penotrometer = 3.5, 4.2, 3.8 kg/cm2			SM	Silty SAND fine to medium grained, black, ~10-15 % low plasticity fines silt, trace organics	M	L	adjacent to low lying natural 'swale' - greener area with higher moisture content ~75 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, dark yellow, ~30-40 % medium platicity clay				
			0.5										
			1.0							M	MD		
			1.5										
				1.70				CI / CH	Sandy CLAY / CLAY fine to medium grained, quartz sand, low to medium plasticity, brown with red orange mottling, trace quartz gravel		VSt - H		
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP03

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386151 m E 6315794 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.10 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					SM	Silty SAND fine to medium grained, black, ~10-15 % low plasticity silt, trace organics	D - M	L	~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow with red, ~25-30 % medium plasticity clay		D		
			0.5	0.50	0.50 m Pocket Penotromer = 2.5, 3.0, 3.0 kg/cm2			CH	CLAY high plasticity, with some quartz sand, trace fine to medium grained quartz gravel	M	VSt		
			1.0										
			1.5										
				1.80				SC	Clayey SAND fine to coarse grained, angular, quartz sand, grey, ~30-40 % medium plasticity clay, trace fine grained quartz gravel		MD		
			2.0						TEST PIT DISCONTINUED @ 2.10 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP04

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386265 m E 6315795 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~15 % low plasticity silt, trace organics	D	MD	Adjacent Mature Trees - possibly more sand cover ~50 mm topsoil	0 5 10 15 20 25
				0.20					pale grey, ~10% fines				
				0.40				SC	Clayey SAND fine to medium grained, yellow with orange, ~25-30 % medium plasticity clay, with weakly cemented / laterized zones		D		
			0.5										
			1.0							M			
				1.30				CL	Sandy CLAY fine to medium grained, quartz sand, brown with grey, trace fine grained quartz gravel				
	L-M		1.5							M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP05

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386071 m E 6315735 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt	D		~50 mm topsoil	0 5 10 15 20 25
				0.20					grey, with some clay				
				0.40				CI	Sandy CLAY fine to medium grained, quartz sand, low plasticity, grey with orange		VSt		
			0.5										
			1.0	1.00	1.00 m Pocket Penotrometer = 2.3, 2.4, 2.6 kg/cm2			SC-SM / CL	Clayey Silty SAND / Sandy Silty CLAY fine grained sand, low plasticity, pale yellow, weakly cemented in parts, trace fine grained gravel	M			
	M-H		1.5								D - VSt		
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP06

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 385885 m E 6315625 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.20 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					ML	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt, trace organics	M		~50 mm topsoil	0 5 10 15 20 25
				0.15				SC	Clayey SAND fine to medium grained, quartz sand, dark yellow, ~30-40 % medium plasticity clay, weakly laterised in parts	D - M	L - MD		
			0.5										
			1.0							M	MD		
			1.5										
				1.70	1.70 m Pocket Penotrometer = 1.6, 1.8, 2.0 kg/cm2			CI-CH	Sandy CLAY / CLAY fine to coarse grained, quartz sand, medium to high plasticity, grey with red and orange, trace fine grained gravel	M	St - VSt		
			2.0										
									TEST PIT DISCONTINUED @ 2.20 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP07

CLIENT:	Mr Andrew McIntyre	COORDS: 386020 m E 6315610 m N MGA94 50	SHEET: 1 OF 1
PROJECT:	260 Treendale Road, Roelands	SURFACE RL: DATUM: AHD	MACHINE: JCB 8035 ZTS
LOCATION:	260 Treendale Road, Roelands	PIT DEPTH: 2.20 m	CONTRACTOR: DRS Contracting
JOB NO:	1772403	BUCKET TYPE: 600m toothed	LOGGED: DMS DATE: 13/1/17
			CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt, trace organics	M	L	~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow with red, ~30-40 % medium plasticity, laterized in parts clay, trace gravel	D - M	MD - D		
			0.5										
			1.0										
			1.5							M			
				1.90				CI-CH	Sandy CLAY fine to coarse grained, quartz sand, medium to high plasticity, grey with red and orange, friable, trace fine grained quartz gravel	M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.20 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP08

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386142 m E 6315621 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.50 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0		DS 0.00-0.20 m Rec = 300/200 mm			SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt, trace organics			Adjacent to open drain ~75 mm topsoil	0 5 10 15 20 25
				0.15				SP	SAND fine to medium grained, quartz sand, grey, trace silt				
			0.5										
				0.65					CEMENTED SAND fine to medium grained, brown, in a cemented matrix, weakly - well cemented, excavated as a sand and fine to coarse grained gravel				
				0.80				SC	Clayey SAND fine to medium grained, quartz sand, orange with grey, ~30-40 % medium plasticity fines, weakly cemented in parts clay, trace fine grained quartz gravel	M	MD		
			1.0										
			1.5										
			2.0							M - W			
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.50 m DEPTH BACKFILLED	W		slow seepage through base	
			3.0										

This report of test pit must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

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REPORT OF TEST PIT: T-TP09

CLIENT:	Mr Andrew McIntyre	COORDS: 386271 m E 6315620 m N MGA94 50	SHEET: 1 OF 1
PROJECT:	260 Treendale Road, Roelands	SURFACE RL: DATUM: AHD	MACHINE: JCB 8035 ZTS
LOCATION:	260 Treendale Road, Roelands	PIT DEPTH: 2.10 m	CONTRACTOR: DRS Contracting
JOB NO:	1772403	BUCKET TYPE: 600m toothed	LOGGED: DMS DATE: 13/1/17
			CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0					SM	SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines , trace organics	M	L	Reeds in paddock from irrigation, low in terms of relative topography Very low infiltration rate, undulating surface from cow hoof imprints	
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~30-35 % medium plasticity clay				
			0.5		DS 0.50-1.00 m Rec = 500/500 mm 1 bag					D	D		20+ refusal
			1.0							M	MD		
			1.5	1.50				CI / CH	Sandy CLAY / CLAY fine to medium grained, quartz sand, medium to high plasticity, grey with red	M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.10 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

This report of test pit must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

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REPORT OF TEST PIT: T-TP10

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 385884 m E 6315464 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.10 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0	0.10				SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity silt, trace organics			~75 mm topsoil	0 5 10 15 20 25
								SC	Clayey SAND fine to medium grained, quartz sand, pale yellow, ~15-25 % low plasticity clay				
			0.5	0.30	BDS 0.30-0.70 m Rec = 400/400 mm 2 bags			SC	Clayey SAND fine to medium grained, quartz sand, ~25-40 % medium plasticity clay, with some gravel	M	MD		
			1.0										
			1.5	1.50	1.50 m Pocket Penotrometer = 3.0, 3.0m 3.6 kg/cm2 BLK 1.70-2.00 m Rec = 300/300 mm			CI / CH	CLAY / Sandy CLAY fine to medium grained, quartz sand, medium to high plasticity, grey with red, trace fine grained quartz gravel	M	VSt		
			2.0						TEST PIT DISCONTINUED @ 2.10 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP11

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386016 m E 6315469 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.20 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines silt, trace organics	D - M	MD	~100 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~30-40 % medium plasticity fines clay		MD - D		
			0.5										
			1.0										
			1.5										
				1.60				CI	Sandy CLAY fine to medium grained, quartz sand, low plasticity, grey with red and orange, trace fine grained quartz gravel, weakly laterised	M	St - VSt		
			2.0		1.80 m Pocket Penotrometer = 1.8 kg/cm2								
									TEST PIT DISCONTINUED @ 2.20 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP12

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386143 m E 6315464 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.50 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines silt, trace organics	M	MD	~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, ~20-25 % low plasticity fines clay, quartz sand, pale brown/yellow				
			0.5	0.50				SC	Clayey SAND quartz sand, orange brown with grey, ~35-50% medium plasticity fines friable clay, trace fine grained quartz gravel		MD - VSt		
			1.0										
			1.5										
				2.00					weakly laterised in parts	M - W			
	M		2.0										
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										

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GAP gINT FN. F01i RL3

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REPORT OF TEST PIT: T-TP13

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386263 m E 6315472 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.30 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines silt, trace organics	M	L	Laser levelled paddock ~400mm lower than other paddock to the south moisture content of soil much higher in paddock ~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow with orange, ~25 % low plasticity fines clay, with some fine grained quartz and lateritised gravel	D	MD		
			0.5		BDS 0.50-1.00 m Rec = 500/500 mm								
			1.0	1.10					close to Clayey Gravelly SAND (SC), medium plasticity	M			
	L-M		1.5	1.70	1.70 m Pocket Penotrometer = 1.6, 1.7, 1.7 kg/cm2			CI / CH	Sandy CLAY / CLAY grey with red mottling, fine to coarse grained quartz sand, medium to high plasticity, trace fine grained quartz gravel	M	St - VSt		
			2.0		DS 2.00-2.20 m Rec = 200/200 mm								
			2.5						TEST PIT DISCONTINUED @ 2.30 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										

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GAP gINT FN. F01i RL3

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REPORT OF TEST PIT: T-TP14

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386359 m E 6315456 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.10 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, ~10-15 % low plasticity fines silt, trace organics	M	L	Adjacent open draining channel ~100 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~25 % low plasticity fines clay	D	D		
			0.5										
			1.0										
				1.20				SC	Clayey SAND fine to coarse grained, quartz sand, orange with grey, ~30 % medium plasticity fines clay, trace fine to grained quartz gravel	M	MD		
	L-M		1.5										
				1.70	1.80 m Pocket Penotrometer = 2.6 kg/cm2			CI / CH	Sandy CLAY / CLAY fine to medium grained, quartz sand, medium to high plasticity, grey with brown and red, trace fine to grained quartz gravel	M	St - VSt		
			2.0						TEST PIT DISCONTINUED @ 2.10 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP15

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 385906 m E 631519 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	L-M		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, with some silty fines, trace organics			<50 mm root zone	0 5 10 15 20 25
				0.20				SC / SM	Clayey SAND fine to medium grained, grey, ~20-30 % low plasticity fines clay	D - M	L		
			0.5	0.50				SC	Clayey SAND fine to medium grained, grey, ~25-40 % medium plasticity clay, trace fine grained quartz gravel, laterised in parts	M	MD		
				1.80					clay content increasing, close to Sandy CLAY				
			1.0										
			1.5										
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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GAP gINT FN. F01i RL3

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REPORT OF TEST PIT: T-TP16

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386021 m E 6315325 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 1.30 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	H		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, with some silty fines, trace organics		L	~50 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND pale yellow, ~40 % medium plasticity clay, trace fine grained gravel, weakly lateritised in parts	D	D		20+ refusal (HB)
			0.5		DS 0.30-0.70 m Rec = 400/400 mm								
			1.0										
									TEST PIT DISCONTINUED @ 1.30 m REFUSAL GROUNDWATER NOT ENCOUNTERED BACKFILLED Slow Excavation Rate				
			1.5										
			2.0										
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP17

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386139 m E 6315318 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M-H		0.0					SM	Silty SAND fine to medium grained, quartz sand, black, with some silty fines, trace organics	D	MD	~75 mm roots moisture content is lower in southern portion of farm	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, trace fine grained gravel, weakly laterised in parts	D - M	D		
			0.5										
			1.0										
				1.30				CI	Sandy CLAY fine to medium grained, quartz sand, grey with red and orange, trace fine grained gravel, weakly laterised in parts	M	VSt		
	M		1.5										
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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REPORT OF TEST PIT: T-TP18

Golder Associates

CLIENT: Mr Andrew McIntyre
PROJECT: 260 Treendale Road, Roelands
LOCATION: 260 Treendale Road, Roelands
JOB NO: 1772403

COORDS: 386273 m E 6315327 m N MGA94 50
SURFACE RL: DATUM: AHD
PIT DEPTH: 2.00 m
BUCKET TYPE: 600m toothed

SHEET: 1 OF 1
MACHINE: JCB 8035 ZTS
CONTRACTOR: DRS Contracting
LOGGED: DMS DATE: 13/1/17
CHECKED: SNH DATE: 4/4/17

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 150 mm
EX	M-H		0.0					SM	Silty SAND fine to medium grained, black, ~15% low plasticity silt, with some silty fines, trace organics	M	L	~70 mm topsoil	0 5 10 15 20 25
				0.20				SC	Clayey SAND fine to medium grained, quartz sand, yellow, ~25% medium plasticity clay, trace fine grained gravel, weakly laterised in parts	D	D		
			0.5										
			1.0										
				1.40				SC	Clayey SAND fine to coarse grained, sub-angular, quartz sand, grey with dark yellow, ~30-40 % medium plasticity clay, trace fine grained gravel, weakly laterised in parts	M			
			1.5										
			2.0						TEST PIT DISCONTINUED @ 2.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										

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Appendix C

Soil Testing Logs (Bio Diverse Solutions, 2021)

Lithological Log

Bore Name:	TP1	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386953E, 6314104N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 20 30 40 50 60	Silty sand	Dark brown	fine	well sorted	dry		
70 80 90 100 110 120 130 140 150 160 170 180 190 200	Sandy clay	dark red/ brown	fine	well sorted	dry	low plasticity	No groundwater encountered
	End of hole						

Lithological Log

Bore Name:	TP2	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386958E, 6314308N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 20 30 40 50 60	Silty sand	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.30m BGL
70 80	Sandy clay	dark red/ brown	fine	well sorted	saturated	low plasticity	
90 100 110 120 130 140 150 160 170 180 190 200	End of hole						

Lithological Log

Bore Name:	TP3	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386814E, 6314503N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 30	Silty sand	Dark brown/grey	fine	well sorted	moist		No groundwater encountered
40 – 90	Sandy clay	orange/ brown	fine	well sorted	saturated	low plasticity	
100 – 200	End of hole						

Lithological Log

Bore Name:	TP4	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386862E, 6314664N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 20 30 40	Silty sand	Dark brown/grey	fine	well sorted	moist		No groundwater encountered
50 60 70 80	Sandy clay	orange/ brown	fine	well sorted	saturated	low plasticity	
90 100 110 120 130 140 150 160 170 180 190 200	End of hole						

Lithological Log

Bore Name:	TP5	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386927E, 6314891N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 20 30	Silty sand	Dark brown	fine	well sorted	dry		No groundwater encountered
40 50 60 70 80 90 100 110 120	Clay	orange/ dark brown	fine sand	well sorted	dry	high plasticity	
130 140 150 160 170 180 190 200	End of hole						

Lithological Log

Bore Name:	TP6	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386989E, 6314629N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 30	Silty sand	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.22m BGL
30 – 90	Sandy clay	brown	fine	well sorted	saturated	medium plasticity	
90 – 200	End of hole						

Lithological Log

Bore Name:	TP7	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386136E, 6314853N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 40	Silty sand	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.34m BGL
40 – 50	Sand	grey	fine	well sorted	saturated		
50 – 100	Sandy clay	light brown	fine sand		saturated	low plasticity	
100 – 150	Gravelly clay	orange/brown	medium gravel		moist	medium plasticity	
150 – 200	End of hole						

Lithological Log

Bore Name:	TP8	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386145E, 6315006N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	Silty sand	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.45m BGL
20							
30							
40							
50							
60							
70	Sandy clay	orange/brown	fine sand	well sorted	saturated	medium plasticity	
80							
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP9	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385911E, 6314826N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	loam	Dark brown	fine	well sorted	moist		Groundwater encountered @ 0.44m BGL
20							
30							
40							
50							
60							
70							
80	sandy clay	light grey	fine sand	well sorted	saturated	low plasticity	
90							
100							
110							
120							
130							
140	End of hole						
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP10	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385623E, 6314764N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	20th Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	loam	Dark brown	fine	well sorted	moist		No groundwater was encountered
20							
30							
40							
50							
60							
70	sandy clay	red brown	fine sand	well sorted	moist	low plasticity	
80							
90							
100							
110							
120							
130							
140							
150	End of hole						
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP11	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386215E, 6315208N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 20	silty sand	Dark grey/brown	fine	well sorted	moist		Groundwater encountered @0.72m BGL
30 – 40 – 50	sand	light grey	fine	well sorted	moist		
60 – 70 – 80 – 90	loamy sand	orange	fine	well sorted	moist-saturated		
100 – 110	clayey sand	orange	fine	well sorted	saturated		
120 – 130 – 140 – 150	sandy clay	orange	fine sand	well sorted	saturated	low plasticity	
160 – 170 – 180 – 190 – 200	End of hole						

Lithological Log

Bore Name:	TP12	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385980E, 6315263N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–50	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.48m
20–60	sand	light grey	fine	well sorted	moist		
60–100	sandy clay	orange/light brown			saturated	low plasticity	
100	End of hole						

Lithological Log

Bore Name:	TP13	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385910E, 6315598N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		
20	sand	light grey	fine	well sorted	moist		
30	sandy clay with gravel	orange/light brown	fine sand, medium gravel	poorly sorted	moist-saturated	low plasticity	Groundwater encountered @ 0.81m
40							
50							
60							
70							
80							
90							
100	End of hole						
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP14	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385666E, 6315332N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.39m
20–40	sand	light grey	fine	well sorted	moist		
40–100	sandy clay	orange/brown	fine sand		saturated	low plasticity	
100–200	End of hole						

Lithological Log

Bore Name:	TP15	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385778E, 6315754N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	Silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.48m
20–120	Sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
120–200	End of hole						

Lithological Log

Bore Name:	TP16	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386193E, 6315791N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		No groundwater encountered
20	sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
30							
40							
50							
60							
70							
80							
90							
100							
110							
120	End of hole						
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP17	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386193E, 6315791N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		No groundwater encountered
20							
30	Sand	light grey	fine	well sorted	moist		
40							
50							
60							
70	Sandy clay	light grey	fine sand	well sorted	moist	low plasticity	
80							
90							
100	End of hole						
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP18	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386462E, 6315142N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.38m
20–130	sandy clay	brown/orange	fine sand		saturated	low to medium plasticity	
130	End of hole						

Lithological Log

Bore Name:	TP19	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386356E, 6315717N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		
20							
30	sandy clay	dark brown	fine sand		saturated	low to medium plasticity	Groundwater encountered @ 0.67m
40							
50							
60							
70							
80	Clay	light orange/brown	fine		moist	medium plasticity	
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP20	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386796E, 6315038N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.37m
20–40	Silty sand	light grey	fine	well sorted	moist to saturated		
40–120	Clayey sand	orange/brown	fine	well sorted	saturated		
120–200							

Lithological Log

Bore Name:	TP21	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386622E, 6315275N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10 – 20	Silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.33m
30 – 40	Sand	light grey	fine	well sorted	moist to saturated		
50 – 70	Silty sand	light brown	fine	well sorted	saturated		
80 – 120	Sandy clay	orange/brown	fine sand		moist	low plasticity	
130 – 200	End of hole						

Lithological Log

Bore Name:	TP22	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386933E, 6315383N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	Silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.40m
30–40	Sand	light grey	fine	well sorted	moist to saturated		
50–120	Sandy clay	orange brown	fine sand	well sorted	moist	low plasticity	
130–200							

Lithological Log

Bore Name:	TP23	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386618E, 6315605N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		
20							
30	Sand	light grey	fine	well sorted	moist		Groundwater encountered @ 0.52m
40							
50							
60							
70							
80	Sandy clay	light grey	fine sand	well sorted	moist	medium to high plasticity	
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP24	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386978E, 6315821N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		No groundwater encountered
20	sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
30							
40							
50							
60							
70							
80							
90							
100							
110							
120	End of hole						
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP25	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	386438E, 6314568N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.35m
20							
30							
40							
50							
60							
70	Sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
80							
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP26	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385748E, 6315087N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.45m
20							
30	Sand	light grey	fine	well sorted	moist		
40							
50							
60							
70							
80	Sandy clay	orange/brown	fine sand	well sorted	saturated		
90							
100							
110							
120							
130							
140							
150							
160							
170							
180							
190							
200							

Lithological Log

Bore Name:	TP27	**Project:**	Treendale Structure Plan Area 3B SSE
Bore location:	385585E, 6315571N	**Job No.:**	MSC0285-004
Drill type:	Hand auger	**Logged by:**	C.Cramer
Hole diameter:	75mm	**Date:**	21st Sep 2021
Total depth:	2000mm		

Depth (cm)	Lithology	Colour	Grain size	Sorting	Moisture	other	Groundwater table
10–20	silty sand	dark grey/brown	fine	well sorted	moist		Groundwater encountered @ 0.42m
20–100	sandy clay	light brown/orange	fine sand		saturated	medium to high plasticity	
100	End of hole						